NEW SCIENTIST

25 July 1963

Soviet aims in astronomy and space research

Professor Sir BERNARD LOVELL, FRS

Engineering design: why do we still get fatigue failures?

C. E. PHILLIPS and N. E. FROST, *National Engineering Laboratory*

Nature's other greens

Dr G. M. BLACKBURN, *University Chemical Laboratory, Cambridge*

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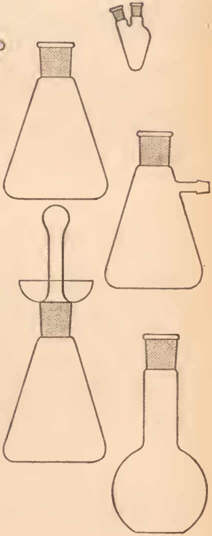

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CONTENTS

Soviet aims in astronomy and space research by **Professor Sir Bernard Lovell, FRS** 174

Engineering design in Britain: The Feilden Report 177

Why do we still get fatigue failures? by **C. E. Phillips and N. E. Frost** 178

Nature's other greens by **Dr G. M. Blackburn** 182

American Newsletter 185

Science in British Industry 186
Radio transmits the strain: Production line for cabbages: The corrosive waters of the Thames: Heat-treating steel by electrolysis: Locating a leak between gas and steam.

Science in Overseas Industry 188
Television keeps the traffic moving: Bacteria to make a packaging film?: Rocket, ahoy!: Watch on the melt: Films of vermiculite: Ore to steel in one plant.

The challenge of experimental medicine by **Dr S. H. Zaidi** 192

Colour television for Europe by **Ronald Brown** 196

Trends and Discoveries 198
Comparing mean sea level in Britain and France: Pine needles record fallout: Italian-US satellite: A new way to find the brain's blood flow: Lilies supply an amino acid analogue: Monkeys and new foods: The best use of bees in orchards: Baiting rabbits: What makes the stable fly start probing.

Letters 201
Recession of the galaxies: Why a loaded wire cuts no ice: London's neglected technology museum: What's in a name?: Change of name: Rule of thumb.

Books 203
Reviews by Tudor G. Ingersoll, Dr N. W. Simmonds and Dr Mary Hesse.

Contributors 205

Classified Advertisements 206

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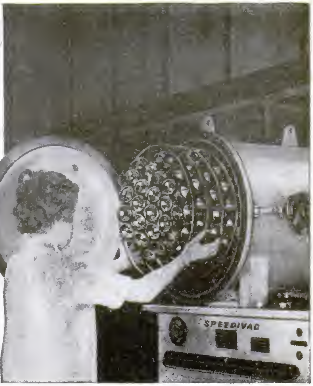

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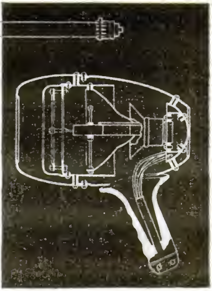

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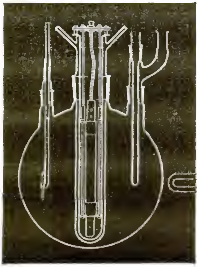

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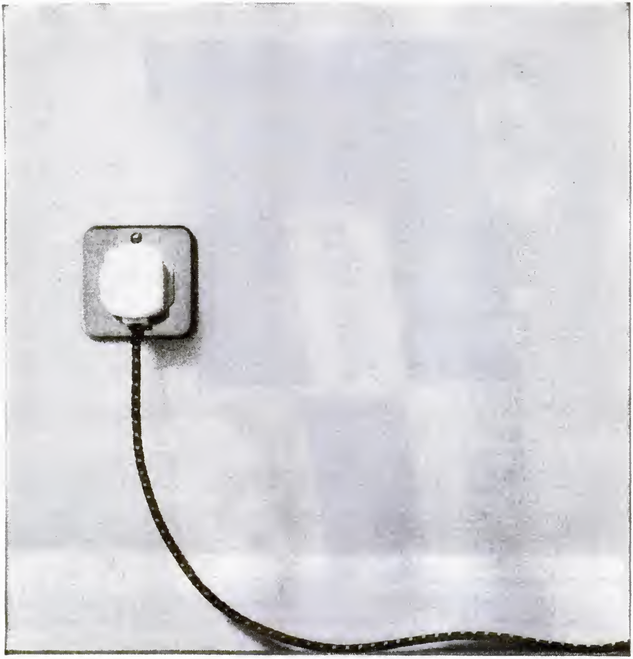

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Notes and Comments

Sunspots to the rescue?

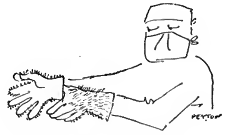
WHAT are we to make of the remarkable message that Sir Bernard Lovell brought back last week from his talks with the President of the Soviet Academy of Sciences? As he relates in his article on page 174 of this issue, Professor Lovell found that Academician Keldysh laid emphasis on the practical difficulties of getting men back alive from a journey to the Moon, and especially on the problem of lethal radiation from the Sun. Academician Keldysh also said that the definition by the world's scientists of the precise purposes of putting a man on the Moon would be the first step towards an international cooperative programme.

That these were more than the casual remarks of one scientist chatting with another is shown by the fact that Academician Ambartsumian, who was present at the conversations, quickly communicated their substance to the International Astronomical Union and that Academician Keldysh was anxious that Professor Lovell should pass them on to high authorities in the West.

Is it, then, a serious bid to open discussions aimed at ending the US-Soviet Moon race (or, what is almost the same thing, a declaration that the Russians are opting out and would be prepared to discuss collaborative ventures)? Professor Lovell believes that it is, and it certainly corresponds with the present political climate revealed by the test-ban talks in Moscow and the recent successful visit of Dr Glenn Seaborg, Chairman of the US Atomic Energy Commission, to the Soviet Union. Some will no doubt view it all with great suspicion. May it not be a device to encourage the already restive US congressmen to chop the Apollo programme so that the Russians can be sure of winning the race? Or may not the Russians have had such setbacks that, thinking the Americans are now likely to win, they want to call the race off? The Americans, we can be sure, will be wary of those possibilities.

Nevertheless, an amicable agreement to end the Moon race would be of such political, economic, and scientific benefit to both sides and to the world at large that the possibility should now be positively pursued. On present showing, the Moon race will reach its climax at a period of maximum sunspot activity, so Academician Keldysh is on firm technical ground when he pinpoints the problem of consequent lethal radiation from the Sun. The Russians have given no description of a lunar landing vehicle and Professor Lovell suspects that the plans do not yet exist; the "Bug" of Project Apollo would afford little protection to the astronauts, and although the Americans are known to be thinking of using very powerful superconducting magnets to deflect the deadly rays there must be doubts about their feasibility in this decade.

There is no reason why Western scientists should not respond to Academician Keldysh's specific proposal that the scientific objectives of a lunar landing should be defined. The International Astronomical Union, the Committee on Space Research (COSPAR) and the International Academy of Astronautics (which is already engaged in studying a project for an international observatory on the Moon) all provide suitable meeting-grounds. There need be no commitment at this stage to an abandonment of present rivalries in a collaborative programme, but the possibility might be brought closer.



Liquid nitrogen freezes brain tissue

BOTH Newcastle General Hospital and Manchester Royal Infirmary now have equipment for carrying out surgical operations on the brain by freezing tissue inside it. Briefly, the technique is to locate a particular part of the brain by X-ray pictures in three dimensions, make a hole in the skull, insert an instrument so that its tip is in the right place and then cool the tip with liquid nitrogen. A spherical lesion is caused in the brain when the temperature at the tip is lowered sufficiently. In fact, the diameter of the lesion is dependent on the freezing time and the temperature reached. For example, with a freezing time of three minutes and a temperature at the tip of the instrument of −40°C, the lesion's maximum diameter is 6 mm; at −50°C the diameter is 8 mm.

So far, the most important application of the technique is in the treatment of Parkinson's disease and, since the Newcastle General got its equipment in June, eight cases have been treated there with success. Most of the treatments with the method have been done in the United States, however, and the distressing symptoms of tremor and rigidity have been abolished in nearly all cases, with no problems of post-operative recovery. There are about 50 American equipments, made by Union Carbide, in action the world over, 40 of them in the USA, though the Soviet Union is also practising "cryosurgery".

Probably the most important characteristic of the low-temperature method of brain surgery is its reversibility. When the temperature at the tip of the instrument reaches 0°C or thereabouts, the surgeon carrying out the operation is able to check the effects of cooling on the reactions of the patient, who remains conscious throughout. If he discovers that

Notes and Comments *continued*

some of the reactions show that the freezing is producing undesirable effects, he can raise the temperature of the tip, and the brain cells then return to normal functioning. If the check shows the right physiological effects, he can go ahead and lower the temperature to make a permanent lesion. Reversibility also means that the surgeon is able to freeze areas in the brain precisely because he can tell from the patient's reactions if the freezing sphere is too large and can then reduce it without damage to the brain cells.

Making the equipment for such operations presented Union Carbide with some tricky problems of insulation, especially with insulation between the freezing tip and the rest of the probe—called the cannula—which must be kept warm. The firm will not say how the solution was achieved except to state that it involved the use of patented "Super Insulation" techniques with glass fibre and aluminium laminations. The silver tip of the probe is cooled by a liquid nitrogen spray, the rest of the probe being insulated by vacuum so that no part of the brain is cooled except in the target area. The liquid nitrogen is supplied to the tip through an inner tube in the cannula, which has an outside diameter of 2.5 mm and the withdrawn heat from the brain tissue transforms the liquid into gas which is then pumped away through an intermediate tube. A thermocouple monitors the tip's temperature which is shown on a recorder so that the surgeon can set the temperature he needs; the equipment will then hold it steady to ±2°C.

Cryogenic surgery is in its early stages and there may be many other successful applications for it in the treatment of such things as brain tumours and glandular disorders. By the use of specially designed instruments it may be possible to seal off part of the brain—reversibly —so that more can be learnt about brain mechanisms and how drugs act on the brain's functions. But the basic idea is not new; the earliest investigation of freezing temperatures applied to the brain was reported in 1883.

Cross-country oil pipeline in Britain

CONSTRUCTION of the Thames-Mersey pipeline for petroleum products should begin next year. The government announced last week that the pipeline scheme submitted by United Kingdom Oil Pipelines Ltd (Esso, Mobil, Petrofina, Regent and Shell Mex and BP) should go forward in preference to the scheme submitted by Trunk Pipelines Ltd (a group of financial and other interests headed by S. G. Warburg and Co Ltd). The government's approval of the UKOP scheme was given under the Pipelines Act of 1962 which was put on the statute book, oddly enough, as a direct result of Trunk Pipelines' original scheme for an oil pipeline between the same two places.

Technically, the differences between the two schemes are slight, apart from the method of laying and the route which the pipes would follow. UKOP propose a more or less direct route from the Thames to Ellesmere Port, on the Mersey, via St Albans, Northampton and Birmingham, with a spur pipeline to Nottingham. The pipes will run underground. Trunk Pipelines, on the other hand, proposed a scheme which would enable the pipeline to follow railways and canals (being laid for long distances under water). Revenue would have been shared with the respective transport boards. The Minister of Power decided in favour of the UKOP scheme because of "assured support", greater economies in the cost of transporting oil, and an initial cost which was between £2 million and £3 million less than that of the Trunk Pipelines project. UKOP hope that construction of the new pipeline will start towards the end of 1964 and that it will begin to operate late in 1965 or early in 1966. Land-owners along the proposed route have been approached and UKOP reports that about 60 per cent have agreed in principle to let the line run through their land provided they get appropriate compensation.

The line will carry light oils motor-car petrol, aviation fuel, diesel fuel, paraffin and liquid feedstocks which are used for enriching town gas supplies and in the chemical industry. It will not carry unrefined oil because this would need to be heated to allow it to flow easily, so the pipeline would have to be insulated. Demand for this type of oil is rising, but not yet to the extent which would justify the additional cost.

Once it begins to operate, no part of the pipeline will ever be empty. "Packages" of the different oils will flow along it in computer-programmed sequence to their respective destinations. They will be separated by Maloney spheres—very tight-fitting rubber balls filled with glycol—and the slight mixture of oils at each interface will be drained off automatically at each terminal. The diameter of the pipes will range from eight to fourteen inches according to the traffic load, and in addition to pumping stations at the terminals there will be pumping stations at each point where the diameter of the pipe changes and at the junction of the spur to Nottingham. The projected pipeline will be linked with the already completed pipeline from Fawley refinery, on Southampton Water, to London.

Although the principal purpose of the pipeline will be to carry oil from the riverside refineries to the oil-hungry Midlands, it is not expected to reduce the number of oil tankers on Britain's roads. It is hoped, however, that the number of tankers operating in central London may be reduced; a depot on the pipeline at St Albans should enable tankers to deliver from there instead of from riverside depots via the congested streets of the city.

Canadian air-scatter radio system

A $5 MILLION communications system which bounces radio waves off the atmosphere more than a mile above the Earth's surface now links the rugged coastal regions of Alaska, British Columbia and the United States along the edge of the Pacific Ocean. This "over-the-horizon" microwave bridge—it is 334 miles long—uses the technique of tropospheric scatter to link Annette Island, Alaska, Trutch Island in Caamano Sound and Port Hardy on Vancouver Island.

Tropospheric scatter, which uses the turbulent lower atmosphere (the troposphere) as a reflector to bounce microwave signals over the horizon, has engaged communications engineers for the past decade, but most systems built so far have been for military purposes. The attractions are the speed with which a system can be installed, and its ability to bridge terrain over which a cable link would be difficult to lay. An important example is NATO's "Ace-High" communications network in Europe.

The new North American system is one of the few large-capacity commercial systems of its kind, having 240 channels for the transmission of speech and data. It has been installed by two subsidiaries of the General Telephone and Electronics Corporation, New York: British Columbia Telephone Company and Alaska Telephone Corporation.

Powerful microwave transmitters installed at Annette Island and Port Hardy feed large directional aerials which direct a beam of microwaves over the horizon. A portion of the beam bounces off the troposphere and is collected by sensitive receivers on Trutch Island, amplified, and retransmitted by the same process to the terminal receivers. The network feeds a conventional microwave chain at Port Hardy and at Annette Island it is linked with civilian and defence communications.

An inclement climate and the sheer size of the aerials needed to collect the scattered signals have made their construction a major engineering task. There are eight in all, two at each terminal and four on Trutch Island; each is 60-ft square, weighs 70 tons, and is built to withstand a 120-mile-an-hour gale and to support an inch of ice.

Adding to the world's supply of protein

A CLUE to greater meat production may be found in the commercial synthesis of the amino-acid lysine, which is now being made by the Dutch Staatsmijnen. Although established over half a century ago as a mining concern, the Staatsmijnen now has ramifications in several other fields such as plastics and biochemistry. It was started as a state-owned organisation but has developed into a large industry, which, like several other state-owned companies in Holland, operates in the same manner as a private company, and profitably. In 1930 the company constructed plant for the fixation of atmospheric nitrogen and from this arose an interest in organic compounds containing nitrogen. This led into the field of plastics and amino-acid synthesis.

In 1958, Staatsmijnen made lysine on a small scale in the laboratory, but it was another three years before it could be produced by a pilot commercial plant. A full-sized commercial plant is now under construction at Geleen in Holland for the manufacture of lysine, which is one of the so-called essential amino-acids that animals and man cannot synthesise in the body for normal growth and nutrition and which must therefore be supplied in the diet. Foods containing solely vegetable proteins do not provide a diet of fully balanced and essential amino-acids. It is because of this that animal products rich in protein, such as fish meal, bone meal, blood and skim milk, which all have a high lysine content, are added to animal feeds. As some quarter of a million tons of protein are required daily by the world's population it is a problem of some magnitude to find enough animal feeding stuffs to give to the animals. Not only more but also better-class animal food is required by the world.

Animal feeds which contain the essential lysine cannot be produced without lysine, and so a vicious circle is set up if we are to rely on lysine from natural sources. This circle can be broken by the large-scale production of synthetic lysine, which could be used to make animal feeds go farther. Moreover animals fed on lysine supplements show increased fertility and are not so fat. This should help further to increase the protein ration of the world.

The commercial synthesis of lysine at the Dutch Staatsmijnen factory is only a start. The amino-acid has also been made in Japan by a fermentation process, although so far it has not been possible to apply this commercially. The commercial synthesis of other essential amino-acids, such as methionine, tryptophane and arginine, may be expected to follow and to contribute to the solution of the problem of the world's supply of protein.

Swedish samples of the highest clouds

RECENT sampling with rockets fired from a Swedish range has provided upper atmosphere physicists with the first definite indication of what makes up the Earth's highest clouds. At a height of some fifty miles there is a sudden drop in the temperature of the atmosphere from freezing point to about −80°C. It is here, in the "mesopause", that the so-called "noctilucent" clouds occur. Their name is derived from the fact that they are only visible at night; they remain illuminated after the Sun has set at the Earth's surface owing to their great height and the effects of atmospheric refraction on the Sun's rays.

The origin of these clouds is generally assumed to be associated with the cold region of the atmosphere but there has been considerable dispute in the past about whether the noctilucent clouds are composed of ice crystals or dust particles. One of the few tentative indications that they might be dust particles was a by-product of the great Siberian meteorite that fell on 30 June 1908—clouds very like noctilucent ones were produced by meteoritic dust in the upper atmosphere.

Now a device fitted to a *Nike-Cajun* rocket launched from Kronogard, N. Sweden, has brought back to Earth the first samples of particles that definitely seem to be constituents of these clouds. The project, a combined venture of the Swedish Space Committee and the US National Aeronautics and Space Administration undertaken by C. L. Hemenway of the Dudley Observatory, Albany, N.Y., R. K. Soberman of the US Air Force Cambridge Research Laboratories, and G. Witt of the Meteorological Institute at the University of Stockholm, is reported in *Nature*.

Out of four attempts to obtain samples last summer, two proved successful. These were similar flights but one was made at a time when the experimenters could see noctilucent clouds, and the other—effectively a control—when they seemed, to both ground and airborne observers, to be absent. The samplers consisted of very high purity, specially prepared surfaces designed to detect solid particles and also to detect whether volatile particles or particle coatings had been deposited. A spring mechanism opened ports on the samplers at a height of about 45 miles, and closed them just below 60 miles.

Examination of the samples after retrieval showed that both flights had resulted in the capture of solid particles, but for the flight when the noctilucent clouds were visible the numbers of particles were higher by two or three orders of magnitude. The particles, moreover, had a size distribution ranging between a twentieth and half a micron, consistent with what was previously known about the optical properties of the clouds.

Under an electron microscope many of the particles from the actual cloud, caught on the sampling surface, could be seen to have a surrounding circular pattern, probably caused by a melted coat of ice which originally surrounded the particle. Those obtained on the control flight did not show these circular patterns. Both dust nuclei and ice thus evidently play some part in the formation of the clouds.

Where do the particles come from? There is still a lot of analysis to do on the Swedish samples. Preliminary composition tests with the electron beam microanalyser indicate that they contain iron and nickel. Some give a consistent but unidentified electron diffraction pattern. Researchers are also extending the statistical analysis. Future experiments are to be undertaken to look into other factors relating to the noctilucent clouds, such as how the particle density varies with height.

An attack on the examination system

"PEDANTRY and the pursuit of mediocrity are in the ascendant", said Sir George Pickering, Regius Professor of Medicine at Oxford, in his presidential address to the British

Notes and Comments *continued*

Medical Association last week. He was attacking the system under which a student's university entrance, studies and subsequent qualification depend mainly on examination results, thus encouraging the "swots" and leaving any character or talent assessment out of the picture.

Sir George's comments emphasise a situation which has become progressively more apparent to those who, like himself, practise a profession and teach it, too. Scientific, engineering and medical studies are particularly affected by the examination strait-jacket because they are based on deduction from known facts. A student who does not know enough facts is easy to discover in an examination, but a candidate who is well equipped with them can relatively easily disguise a lack of deductive and intuitive ability in the subject.

The result has been frequently observed—those with the best paper qualifications in a subject are by no means always the best qualified. The artificial conditions of an examination in which problems are set to be solved in a fixed time with few, if any, sources of reference are, psychologically, as bad as they could be. Indeed the "good" examinee may possess qualities diametrically opposed to those required for good professional practice.

This question, when raised about the "11-plus", has always produced great heat and set tests for eleven-year-olds have been modified or even abolished. But the same considerations apply to all examinations that are faced later.

The probable answer to Sir George's charge is a greater use of the assessment system over the entire period of study. If a finger-tip knowledge of facts is required, then examinations of lower standard would almost certainly fill the bill. But to find out whether a student is suitable to become a doctor, physicist, engineer or teacher it is essential to watch him at work and to judge accordingly.

There are signs that a more liberal approach to examinations is slowly evolving. Limited, or even free, use of source books is now allowed in some advanced medical and scientific examinations and the set tasks are tending to place a greater premium on interpretation, though the artificial time limit remains.

Assessments, too, are more widely used, most frequently as a check on written examinations but sometimes as a major factor in their own right. A common snag is that good teaching presupposes a personal relationship between teacher and student and some degree of bias is almost unavoidable. But there are statistical means of dealing with small personal error. Beyond this it would be unrealistic not to rely on professional judgment.

Sherlock Holmes said that *all* facts should be relegated to the filing cabinet, leaving the mind uncluttered for deductive reasoning. Few psychologists would agree with the implication that reasoning capacity is diminished by knowing the facts. But most people in the scientific professions would agree that how many facts a student has off by heart is one of the less important standards for judging professional ability. What must be known is his ability to do the job, which the present examination system discovers hardly at all.

Seventy-five years of Dunlop tyres

JOHN BOYD DUNLOP was not the first inventor of the pneumatic tyre nor was he most responsible for its commercial success. Yet he is the man who, in popular mythology, gets the credit for its invention. The value of possessing an inventor's name no doubt encouraged the Dunlop company to build up his reputation, though, in fact, acrimony marked their relations; and he did have the advantage of living for many years after the pneumatic tyre had become a familiar article, while having his name and face used virtually as Dunlop's trademark. Now, 75 years after he applied for his patent, the company is again celebrating the existence of its famous creator and, in spite of all the things he did *not* do, Dunlop deserves to be remembered as the man who started the development of the pneumatic tyre at the time when a market existed for it—on the bicycle.

When Robert Thomson invented the pneumatic tyre in 1845, it could be used only on carriages and the construction that he employed was not really robust enough to stand up to regular use on the nail-strewn roads of the time. Thomson, however, continued to use them on his own carriages until his death in 1873. He at least demonstrated the reduced rolling resistance that the pneumatic tyre offered on rough surfaces and he published his results in the *Mechanic's Magazine*, so this was by no means a hidden invention even if it was stillborn. When Thomson turned to work on steam traction engines later in his life, he adopted solid rubber tyres, for he had to accept that his pneumatics were unsuitable for such heavy vehicles.

If Dunlop had not hit upon the idea of the pneumatic tyre in 1887, when looking for ways of making his son's bicycle run more easily and smoothly over the cobbled streets of Belfast, somebody would probably have turned up Thomson's patent and seen its utility some time in the next decade or so. But the delay would have made a significant difference to the development of the tyre, of the cycle industry and then of the motor industry that grew out of it. Even after Dunlop obtained his patent, without the Patent Office realising he had been anticipated, it was two years before Thomson's was discovered.

Having lost the monopoly that it thought it possessed, the Dunlop company only managed to gain its predominance by the toughness and commercial acumen of its first managing director, the Dublin paper merchant Harvey du Cros, which led him to buy the key patent on means of securing a tyre to the rim. It was taken out by C. K. Welch, and covers the method now universally used. With this protection, the company flourished through the 1890s, though Dunlop himself, after fading into the background, resigned from the board in 1895 and was thereafter active amongst the company's competitors.

Is there an atmosphere around Mercury?

THE planet Mercury, with a diameter of about 3000 miles and gravity much less than the Earth's, has been generally regarded as virtually devoid of atmosphere. Various "obscurations" of the surface markings, reported many years ago by G. V. Schiaparelli and E. M. Antoniadi, have not been confirmed, and Audouin Dollfus, who has carried out a long series of observations with the refractor at the Pic du Midi, has never been able to record them, so that their existence is extremely doubtful. On the other hand, Dollfus, using polarimetric methods, announced in 1953 that he had established the presence of a highly tenuous atmosphere round Mercury. The ground density was about 3/1000 of that of the Earth's atmosphere at sea-level, corresponding to a pressure of about 1 mm. of mercury metal. This is what is usually termed a laboratory vacuum, and an atmosphere of such an order would be unable to support any form of Earth-type life, even if the conditions on Mercury were suitable in other ways. Dollfus did not speculate as to the composition of the atmosphere, and the observations were, of course, extremely difficult and delicate.

The only time when Mercury may be observed high in the sky against a relatively dark background is when the Sun is hidden, during a total solar eclipse. In February 1961, a total eclipse was visible from the Crimean Astrophysical Observatory, and N. A. Kozyrev took advantage of it to make observations of Mercury in an attempt to confirm the existence of an atmosphere there. Conditions were good, but the results were negative.

Rather unexpectedly, Kozyrev has now announced some new results which favour the presence of a Mercurian atmosphere. With the Crimean reflector, he has obtained twenty spectrograms of the planet, and has detected emission lines which he believes to be due to luminescence in the atmosphere of Mercury; he even suggests that the density may be as high as 1/100 that of the terrestrial mantle. The emission lines are attributed to hydrogen.

There have been no previous suggestions that Mercury could be associated with a hydrogen atmosphere; in view of the planet's low escape velocity, light gases would be expected to be lost very rapidly. Kozyrev does not believe, however, that the atmosphere is "permanent" in the accepted sense of the word. On his theory, the hydrogen is steadily lost into space, but is replenished by fresh hydrogen sent out by the Sun and collected by the planet; he calculates that the atmosphere is entirely renewed in a period of about 100 000 years.

Kozyrev's results, announced at a conference held at the Pulkovo Observatory in Leningrad, are bound to cause controversy, just as his lunar observations have done, and it is not likely that they will be generally accepted until full confirmation has been obtained elsewhere. However, his work is of the greatest interest, and serves to emphasise that the question of the existence or non-existence of a tenuous atmosphere around Mercury is still completely open.

Hydrofoil craft to hunt submarines

THE latest recruit to anti-submarine warfare has wings that are submerged in the ocean. It is a 50-knot hydrofoil craft, built by Boeing and about to enter service with the US Navy, specifically to hunt and destroy high-speed submarines; it is expected to be the precursor of a swift new family of naval craft.

The salient point about the hydrofoil is its high speed and efficiency, achieved by employing wing-like "foils" that raise the vessel clear of the water at speed, so eliminating the drag of water on the hull. In this way it is hoped to reach speeds of 100 knots—speeds that require electronic controls of a complexity comparable to those of an aircraft.

Boeing's hydrofoil, *PCH 1* (patrol craft, hydrofoil), is powered at speed by two Bristol Siddeley Proteus marine gas turbines, each of 4250 h.p. It uses two 11-ft-long foils, totally submerged, by means of which its hull is lifted clear of the water at about half-speed. These foils are retracted into the hull at low speeds or in shallow water.

Automatic stabilisation equipment similar in design to that used in aircraft has been developed for *PCH 1* to control its altitude and its attitude in pitch and roll; this also senses the yaw rate and controls the craft during tight, fast turns.

"Leap-frog" tactics by a pair of hydrofoils have been worked out by naval experts, in which the first craft will hunt by sonar with its foils retracted. If it detects a submarine, it will guide the second craft towards the target at high speed. This craft, on reaching the position, will retract its foils and employ its own sonar, then provide its companion with a fresh "fix": and so on, until the submarine is pin-pointed.

Further hints of Labour science policy

THE idea of a Ministry of Higher Education and Research, to implement a programme of university expansion sustained at the maximum practicable rate, was favoured at a private meeting on science organised by the Fabian Society in London on 20 and 21 July. After the meeting, Mr Richard Crossman, the Opposition's chief spokesman on science, who presided, together with Professor P. M. S. Blackett and Dr B. V. Bowden, who also played a leading part, reported the trend of the discussions. Over 70 people—MPs, scientists, social scientists, industrialists and others—had participated, including Mr Harold Wilson, Leader of the Opposition.

The meeting was called to discuss the interim conclusions of working parties examining the problems and opportunities of science in industry, of manpower and higher education and of science and government, with a view to advising the Labour leadership. Mr Crossman said afterwards that Mr Wilson had emphasised the importance of the application of science in industry. He also said that even if there were a general election soon his party would have a science policy ready; if it were postponed, the studies would continue. He drew a parallel between the scope of his private groups and that of the Robbins and Trend committees advising the government. The meeting had supported the idea that an Association of Labour Scientists should be set up.

Summarising the views of the meeting on the universities, Dr Bowden (principal of the Manchester College of Technology) said that there should be continuous and steady growth at the maximum practicable rate and that British universities should now accept the obligations to society that they had hitherto neglected. Suggesting that there was almost unlimited scope for expansion, Dr Bowden pointed out that, while a child born in California in 1944 had a 1 in 2 chance of going to a university, a child of the same age in Britain had only 1 chance in 25. The present government was looking to a student population of 170 000 by the early 1970s; the Labour scientists were planning for 280 000 by the late 1970s. Big universities of 10 000 or more students, rather than a multiplicity of small ones, were preferred, so that new disciplines could develop rapidly. There was a special opportunity for urban renewal of northern cities in this policy.

Professor Blackett pointed out that the cost would be relatively small—rising from 0.6 per cent of the gross national product to about 1.5 per cent, and that, although there would be resistance from some academics, rapid expansion and plenty of money made new ideas easier to implement. "Academics seldom refuse money", he remarked.

The Minister of Higher Education and Research, it was said, would be fully responsible for the humanities as well as for science at the universities. One can deduce from this that the Labour scientists must also be thinking of hiving off the Minister for Science's responsibility for science in industry to a Minister of Technology, otherwise the set-up would be too cumbersome: if so, the Minister for Science as such would disappear.

Notes and Comments *continued*

British research into parapsychology

PERIODIC reports of increasing research into extrasensory perception (ESP) in the Soviet Union have raised the question of whether comparable studies are in progress in Britain. Scientific interest in the possibility of telepathy and alleged related phenomena seems to be very limited and recently several experiments appear to have failed. The academic prestige of the subject has suffered from the critical attacks of Mr C. E. M. Hansel of Manchester University who has argued (see *New Scientist*, 26 February, 1959) that the possibility of fraud has not been ruled out of otherwise adequately designed experiments, and the best researchers are conscious of the extreme difficulty of devising repeatable experiments.

The investigation of ESP has traditionally been the province of the 80-year-old Society for Psychical Research, but the last eight numbers of the Society's *Journal* have not recorded a single experimental study taking place in Britain. The most active researchers, Dr S. G. Soal, Mr G. W. Fisk and Dr D. J. West, the president of the Society, are apparently no longer engaged in experimental work. The extraordinary public interest still commanded by ESP research, coupled with the almost total lack of systematic experimentation, suggests that the Society fulfils a philosophical and social rather than a scientific purpose.

The only academic centre in which ESP research has become established is Oxford. In 1961, a parapsychological laboratory was organised as a research section of the university's Unit of Biometry. It is presided over by an American, Mr Stephen Abrams, whose researchers are proceeding on the assumption that ESP is an unconscious function associated with a high degree of personality disassociation. Thus most of their work has centred around hypnosis which they interpret in terms of Pavlovian conditioning. They have reached the conclusion that extrasensory responses are best handled and explored as forms of conditioned reflexes. According to Abrams, the advantages of this approach are the ease with which conscious intervention is eliminated and the opportunity of reinforcing and thereby encouraging extrasensory responses. The conditioned hypnotic responses employed in these experiments include motor activities such as clapping hands and hallucinations of taste. The subject involuntarily claps hands at the "right" time or he "knows" which of two "identical" cigarettes has been conditioned to taste like toothpaste. The conditioning experiments have been supplemented by a repetition of Soviet research on the telepathic induction of hypnosis, studies in the paranormal transmission of drawings with Dr Soal's subject, Basil Shackleton, and investigations of the mechanisms of subliminal perception. Critics of ESP have been invited to join in the research and one exploratory experiment has been conducted in collaboration with Mr Hansel. The undergraduate Society for Psychical Research which arose out of the old (1878) Phantasmagorical Society, has been closely associated with the work of the parapsychological laboratory.

"Just my luck to marry a zoologist!"

A second research group in Oxford, the Psychophysical Research Unit (which is not connected with the University although its three members are graduates) is planning physiological studies of ESP and is for the moment engaged in research relating card guessing scores to image interpretation and personality measures. They also conducted a mass card guessing experiment on television last year but have not drawn any conclusions owing to the small number of responses (300).

At Cambridge the Society for Research in Parapsychology is more than a hundred years old and its membership normally exceeds a 100. The president, Mr E. Garth Moore is a Fellow of Corpus Christi. Other members include Professor C. D. Broad, Dr R. H. Thouless and Dr West. The Perrott Studentship in psychical research at Trinity College is currently vacant. At present the attention of the Cambridge Society is centred on an investigation led by Mr Anthony Cornell on the possibility of registering thought impressions on sealed photographic plates. Dr A. G. Owen, a bio-statistician, has carried out card guessing experiments and an intensive analysis of alleged poltergeist hauntings. Experiments in long-distance telepathy are being planned.

In London, Mr George Medhurst, an SPR council member and research scientist in industry, has organised and carried through a large-scale investigation of card guessing with 1200 subjects. Twenty-six subjects obtained highly significant scores in unsupervised tests but no clear-cut evidence of ESP seems to have emerged in intensive re-testing of these subjects under experimental conditions.

Dr Alan Gauld of the Psychology Department, Nottingham University is presently engaged in the planning of experiments with animals; at Liverpool University, Dr Cedric Wilson and Mrs Pamela Huby have conducted unsuccessful experiments, using drugs to influence card guessing scores. An attempt by Dr John Beloff and Mr Leonard Evans at Queen's University, Belfast, to measure the influence of thought on a radioactive source also ended in failure.

A new date for the earliest Australians

WHEN was Australia first inhabited? Up till now, the question has been extremely difficult to answer with accuracy. A radiocarbon date of 10 950 BC ± 170, just announced for an occupation layer in Kenniff Cave, Central Queensland, provides the first stratigraphical evidence that man reached Australia before the end of the Pleistocene period. The sample was provided by Dr D. J. Mulvaney, of Melbourne University, who has done much work on the prehistory of Australia. The sample was dated at the National Physical Laboratory at Teddington, England, and the results are announced in *Radiocarbon*, which is published annually by the *American Journal of Science*.

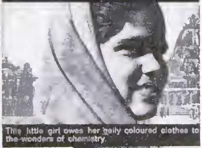
The dated layer at Kenniff Cave is 6 ft 3 in. below the surface and it is underlain by over 3 ft of occupation layers as yet undated. It seems, therefore, that the Australian aborigine has quite a respectable antiquity. Another very interesting fact has emerged as a result of these excavations. The lower part of the deposit is full of implements whose parallels are with Tasmanian rather than mainland types.

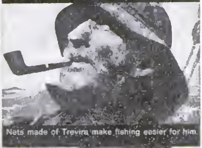
The Tasmanians—who became extinct during the last century—were quite different in appearance to the Australian aborigines. They had a very dark skin, frizzy hair and round skulls like the Negritos. Some anthropologists have suggested that they arrived direct from Melanesia rather than via the mainland of Australia. The finds from Kenniff Cave, however, suggest that the first immigrants to Australia were ancestors of the Tasmanians, who were pushed out by later waves of settlers of the type represented by the Australian aborigines. The last vestiges of these original pioneers may have lingered on in Tasmania until a century ago.

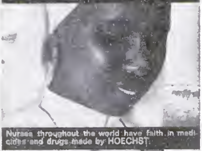
A CENTURY OF HOECHST

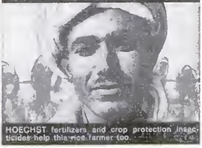
Farbwerke Hoechst was founded in 1863. During the hundred years since then, chemistry has made life easier and more beautiful. People live longer and the soil yields richer crops; living has been made more comfortable and people dress better. In these achievements, Hoechst has played a significant role.

Pipes made of Hostalen irrigate the pastures of this Irish farmer.


This little girl owes her gaily coloured clothes to the wonders of chemistry.


Nets made of Trevira make fishing easier for him.


Nurses throughout the world have faith in medicides and drugs made by HOECHST.


HOECHST fertilizers and crop protection insecticides help this rice farmer too.

people matter most

1863-1963

THEN	NOW
Paints were a luxury Until 1860, man had to make do with natural colouring matter. He had to be satisfied with a handful of shades, and it was well-nigh impossible to produce fast dyeings. Gay raiments were reserved for the rich.	**Gay colours for all** The road from the first aniline dyestuffs produced by Farbwerke Hoechst to the wide range of modern dyestuffs encompasses a long and historic chapter of research. Today, gay posters, colourful textiles and bright clothes are an accepted feature of the daily scene.
Life expectation—forty The average expectation of life in 1863 was about forty years; infant mortality was disastrously high. There were no adequate remedies against infection or pain.	**Life expectation—seventy** Throughout the world, Hoechst pharmaceuticals help to fight infection, to mitigate pain and to maintain health. Many of these preparations have become milestones in the history of medicine.
A starving world In 1900 the world population was around 1500 million. It was calculated that it would double in less than fifty years. Where was the food for these hungry millions to come from?	**Fertilizers increase crops** High-grade cultivated plants rob the soil of important nutrients, but mineral fertilizers restore the natural balance. Throughout the world, Hoechst fertilizers and plant protection agents increase the yield of the soil.
Nature's limitations Our ancestors had available only the materials provided by nature whose application was limited by their inherent shortcomings: iron is heavy, glass may break, wood may rot.	**Plastics—made to measure** Chemistry created new materials tailored to the needs of man and combining many advantages: plastics supplement traditional materials and open up new vistas in construction and design. They are light in weight, durable and do not corrode.
Nature's fibres In the search for suitable clothing man used the fibres that he found in nature: wool, cotton, linen and silk. These materials, however, did not fully satisfy modern trends.	**Man-made fibres** man-made fibres are the result of sustained attempts to rearrange the building bricks of nature. Chemists provided the new fibres with properties that fulfil the requirements of modern man and that ideally supplement those of the natural fibres.

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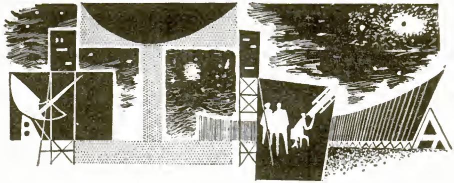
Soviet aims in astronomy and space research



The author, who returned last week from a tour of Soviet observatories, sees important new opportunities for collaboration with the Russians in radio astronomy—making use of their splendidly equipped secret deep-space tracking station—and perhaps eventually in space exploration as well

by Professor Sir Bernard Lovell, FRS

Director, Nuffield Radio Astronomy Laboratories, Jodrell Bank

DURING the past six years we at Jodrell Bank have been able, by means of the 250-foot radio telescope, to make some important contributions to the development of radio astronomy and also to render some assistance to both the Americans and the Russians in tracking their deep-space probes. For me, a happy consequence was an invitation from the Soviet Academy of Sciences to visit radio and optical astronomy observatories in the Soviet Union. Three weeks spent travelling to nine observatories and affording free discussions with eminent Soviet scientists would have been exciting enough, even if there had not been the added piquancy of seeing important equipment that has hitherto been hidden from Western eyes. I was able to work out, with the Soviet Astronomical Council, specific schemes for collaboration between Jodrell Bank and this secret deep-space tracking station in radio astronomical work. Perhaps of even greater significance were the indications I had from the President of the Soviet Academy of Sciences of his wish to promote talks with the West on the advisability or otherwise of pursuing a programme for landing a man on the Moon.

Before examining these new opportunities, it is as well to put them in perspective by describing what I saw and heard about the present and future activities of the Soviet astronomers themselves. I was particularly struck by the close collaboration between optical astronomers, radio astronomers and space researchers that was in sharp contrast with the distinction between the three species that is unfortunately usual in the West. The Soviet attitude is shown by their use of their biggest optical telescopes for photographic tracking of their space probes.

It is also typified by a model that I saw at Pulkovo, the observatory near Leningrad that is the traditional home of Russian astronomy but has now lost pride of place to the great observatories of the south. This model was of a much larger version of a radio telescope that exists at Pulkovo consisting of 90 plates, arranged in an arc, that can be tilted to direct radio waves from a selected region of the sky to a central focus. The proposed new instrument would have 550 plates, each 15 metres by 6 metres, having an effective aperture of 2 kilometres. If it is built, it will be a formidable instrument; and I understand—and this is the point I wish to make—that it may be sited in the Caucasus alongside the greatest project of the optical astronomers, the 6-metre (236-inch) optical telescope, which will be the largest in the world. The first orders for the latter instrument have been placed and the construction of the very expensive approach road up the 2000-metre mountain chosen for it has begun.

But this community of purpose between the optical and radio astronomers already takes tangible form in the other observatories. For example, at the Crimean Astrophysical Observatory important optical work on the magnetic fields of sunspots is reinforced by simultaneous radio studies and, as the new 100-inch optical telescope is being commissioned, work is proceeding at a beach site on a 22-metre radio telescope to operate at millimetre wavelengths; it is due to be finished this year.

At the Byurakan Astrophysical Observatory in Armenia I saw the extremely interesting optical work of B. E. Markarian that is directly relevant to one of the questions exciting most interest among radio astronomers at the moment: the nuclei of galaxies. It has become clear that the very powerful radio sources formerly attributed to the collision of galaxies more probably owe their unique properties to the peculiar nature of their nuclei—as, indeed, the leading Soviet astronomer, Academician Victor Ambartsumian, suggested in 1958. What Markarian has done is to study 400 galaxies and find that the light from the nuclei of 32 of them cannot be explained by emission from stars, so that there is some other mechanism involved, probably "synchrotron" radiation. Ambartsumian believes that these galaxies may be less extreme examples of the peculiar radio galaxies, such as *3C273*, that radio astronomers have recently been studying in detail (see Professor Fred Hoyle's article, *New Scientist*, 28 March). Markarian uses the 40-inch Schmidt telescope for his work, but a 100-inch telescope is now being ordered for the same observatory. There is a radio interferometer at Byurakan similar to Ryle's earlier pattern at Cambridge, and a design study for a 200-metre steerable telescope—although there is no indication of an early start on its construction.

I visited one "pure" radio astronomy observatory, at Serpuchov near Moscow. There the biggest instrument in service is a 25-metre dish, having the unusual feature that, for its work in recording millimetre waves from the planets, it is sighted on the planet by an observer looking through an optical telescope mounted in the centre of the dish. There is also a large "cross" instrument that is not yet complete: its main aerial is 40 metres wide and 1 kilometre long.

By far the most remarkable radio observatory in the Soviet Union is, however, the deep-space tracking station in the Crimea. There I saw aerials and electronic equipment provided with a lavishness that one does not find elsewhere in the Soviet Union. I estimated that the equipment was worth about £20 million by British standards, and, what was just as remarkable, the whole thing was evidently built in a year, in 1960. As few Russians have been able to visit the place, I felt very privileged at being the first Westerner to go there.

The primary purpose of the station, and the reason for its existence, is the tracking of lunar and planetary probes; it was from here that the abortive Venus and Mars probes were commanded. It belongs to the Institute of Radiotechnics and Electronics, directed by Academician V. A. Kotelnikov.

There are three identical aerial systems spaced out over ten kilometres; one is a transmitter and the others are receivers. Each consists of eight 16-metre fully-steerable dishes arranged in two rows of four, providing the equivalent of a 150-foot aerial. There is comprehensive equipment for working at 920 Mc/s (32-cm wavelength) and at other frequencies. The receiving equipment is superb, making use of cooled parametric amplifiers and masers, the like of which we shall not have on the Jodrell Bank radio telescope until the end of this year.

In spite of the priority given to deep-space tracking there is some valuable radio astronomical work in progress. We had already heard about the radar echoes obtained from Venus, Mars and Mercury using these facilities, and the powerful transmitters, frequency standards, and computing equipment, which are all-important in this work, are outstanding. Radio observations of the occultation of sources by the Moon, and of the intensities of the emissions from the galaxy M31 and from the planets are also in progress.

It was at the instigation of Academician M. V. Keldysh, President of the Academy, that I considered what forms of collaboration in radio astronomy might be possible, and it was clear that the powerful equipment at the deep-space tracking station was by far the most interesting from this point of view. In subsequent discussions, three projects emerged that seemed suitable for collaboration.

The first is relatively easy to arrange, because it concerns a line of research in which I am personally engaged and in which the Russians are already cooperating. It is the study of "flare" stars, the first individual visible stars from which radio signals have been detected. Readers of my article on "The discovery of true radio stars" (*New Scientist*, 25 April) will recall that this research involves watching individual stars of a particular type for optical evidence of flaring and examining the radio record for increases above the background noise occurring at the same time. The Smithsonian Institution of the United States and the Byurakan Observatory in the USSR have both been helping me on the optical side—indeed when I met Ambartsumian on my travels he greeted me with news of a flare on the star Ross 154 on 28 June; unfortunately it proved to have been below the horizon from Jodrell Bank at the time.

I hope that, as a result of my visit, this optical assistance will be extended by other Soviet observatories. I am also optimistic about the possibility of arranging simultaneous radio observations of the flare stars by Jodrell Bank and the Crimean deep-space tracking station. There is a special scientific interest here: we have a suspicion that radio bursts may originate from these stars without a corresponding visible flare but we can confirm this effect only by simultaneous observations from two widely spaced stations.

A second collaborative programme that we discussed concerns the use of Jodrell Bank and the deep-space tracking station as a "bistatic" radar for bouncing pulses from one station off the planets and receiving them at the other—a procedure similar to that which we carried out at Jodrell Bank in collaboration with the Americans, for bouncing signals off the Moon. Some modification of equipment would be necessary at both stations, but if, as we hope, we can carry out this programme for Mars, Venus and Mercury we should be able to check our measurements of the dimensions of the solar system and obtain new information about the rotation of the planets and about the interplanetary medium; we may also learn something fresh about the nature of the planetary surfaces.

The third proposal is altogether more difficult and more ambitious, but the Russians do not think it impossible. A particularly successful line of research at Jodrell Bank during the past few years has been the measurement of the apparent sizes of radio sources in the sky. Such information provides important clues about the distance and nature of these sources that in turn bear crucially upon the interpretation of radio sky-surveys as indications of the nature of the universe as a whole. These measurements require at least two radio aerials a considerable distance apart; the largest baseline we have used at Jodrell Bank has been 72 miles, using the 250-foot dish in conjunction with a smaller aerial in Lincolnshire; it enabled us to measure diameters down to one second of arc. If the theoreticians are right in thinking that the central regions of galaxies responsible for much of the radio emission are small, it is important for us to extend our baseline and reduce the size of the smallest measurable diameter. That is why I raised with the Russians the possibility of using the Crimean deep-space tracking station for this purpose; it would give us a baseline of 1600 miles and a 60-fold improvement in our angular measurements. But we shall have to set up a working party to investigate the technical problems.

On four occasions the Russians have asked Jodrell Bank for urgent help in observing their deep-space probes. It is possible that, as a result of my visit, we shall get earlier information about their launchings so that we can help them more effectively. I offered to accommodate a team of Russians at Jodrell Bank, similar to American teams we have had working with us, and this is being considered.

It was in my discussions with Academician Keldysh about the Soviet space programme that the big surprises came. A month ago I believed, like everyone else in the West, that the US-Soviet Moon race was a real struggle. Now I seriously doubt it.

Keldysh spoke with great enthusiasm of the plans to establish a manned optical observatory within five years, to be put into orbit at a height of 100 to 150 miles and to carry a 36-inch optical reflector, an astronomer and an engineer. The immense advantage of a telescope in space is, of course, that it is clear of the disturbances and absorption of the Earth's atmosphere. The Americans have plans for unmanned orbital telescopes but the Russians intend to exploit the space rendezvous techniques that they think they are on the point of mastering in order to have a manned observatory where the crew could work for spells of five or six days.

There is also enthusiasm for landing instruments gently on the Moon's surface—and on the planets as well. But when we turned to manned lunar landings, Keldysh put great emphasis on general technical difficulties of getting the men back alive and especially on the seemingly insuperable dangers of the radiation from solar flares that could quickly kill them. The flare problem is manageable, the Russians believe, in the case of the orbital observatory because the few minutes' warning of heavy radiation that is now possible would be sufficient to bring the crew down to a safe level.

Keldysh told me quite explicitly that he thought that the right way to proceed with the Man-to-the-Moon problem was to have international agreement among world scientists about the desirability and value of a lunar landing. He thought, indeed, that a delineation by scientists of the real purposes in sending men to the Moon would be the crucial step in putting space research on an international basis.

The opinions voiced by Keldysh in the course of our discussions have since then already been communicated to the International Astronomical Union by Ambartsumian, who is President of the Union. For my part, I have written to Dr Hugh Dryden of the US National Aeronautics and Space Administration and to Lord Hailsham, reporting in more detail on this part of my conversations with Keldysh.

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Engineering design in Britain

The Feilden Committee was appointed in May 1962 to examine the standing of mechanical engineering design in Britain and to recommend any necessary changes for improvement. Its report was published last week

GRAND old British tradition can run a firm into the ground. The Feilden Report on mechanical engineering design gives an example, though it calls it extreme. The North British Locomotive Company Ltd, which wound up in 1962, died like a dinosaur from an inability to adapt to changing conditions. It delayed so long in turning from the exclusive building of steam locomotives to the building of diesels that when it was forced to do so in an effort to keep going it was too late. Its staff and work people had no experience of precision engineering and were still "steam-minded". (On the day the report was published, there were photographs in the press of the Royal Scot being taken by road to a holiday camp in Skegness for permanent exhibition.)

The case of North British is quoted in the section of the Feilden Report dealing with the present standing of British engineering design. Most of the evidence given to the Committee pointed out that some parts of industry have failed to keep up with technological advances in re-designing their products; signficantly they were all old-established ones making traditional products. To be fair, at least some of the present trouble has arisen because these industries have made successful products in the past—good, reliable machines—and as customers preferred to buy what they knew to be good when they wanted new ones, it is not difficult to understand why design development on them has been more or less a matter of tinkering. Besides, bright engineers and designers wanted to get into the new industries after the war, and there was an immense market for traditionally designed British goods.

This state of affairs is now at an end. The Federation of British Industries statement to the Committee, while paying tribute to the present standing and reputation of British engineering design as "generally good" nevertheless went on to say that "if Britain is to conquer the proportion of a competitive world engineering market necessary to maintain our standard of living, quite drastic alterations will be needed to the present arrangements".

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Co-opted members: B. K. BLOUNT, *Department of Scientific and Industrial Research;* F. D. PENNY, *National Engineering Laboratory.*

From the outset, the Feilden Committee were determined not to start sliding into aesthetics. In the event they did not have to. They found, apparently, that when they were discussing appearance they were really talking about engineering values for the most part. So some of the words applied to British engineering products turned out to mean that there was a lack of knowledge of the properties of materials, poor detailing and no thought of how the machines were going to be maintained or operated conveniently. The words, quoted in the report, were shorter —"lumpish", "rough", poorly-finished", and "old-fashioned", At least some of the customers now think the same. British exports of engineering products have been increasing, but they have not been increasing at the rate that the international trade is, the net result being that Britain's share has shrunk.

It seems extraordinary that firms are still being caught out for lack of design staffs who appreciate a changing world. Some of them have still not mentally accepted the end of the war as a fact and are producing goods to pre-war designs. What borders on the incredible is that British design in the newer fields of technology may be just as bad. Equipment for military aircraft, because its design does not take advantage of up to date knowledge of materials and fabrication, is so unreliable that maintaining it accounts for half the total cost of the Royal Air Force.

However, there is not much point in examining the present situation simply to raise eyebrows. The more important part of the report is aimed at changing the attitude of our society to engineers and of industry to engineering designers.

Many other professions are thought to be higher in the social scale than engineering. The Feilden Report quotes a survey made at the University College of South Wales and Monmouthshire, this time with the general public, which bears out the results of a previous survey made by the Oxford University Department of Education among sixth form schoolboys. In a list of ten occupations, rated by status, the professional engineer came seventh after doctor, solicitor, university lecturer, research physicist, company director, dentist and chartered accountant.

In industry, firms often do not know the difference between a draughtsman and a designer. People practising other professions than that of the engineer are paid more. Even when engineers are highly paid, few of them are employed on design. In fact, it is clear from the report that large sections of industry have no idea of what they want designers to be or do and there is confusion at educational level.

The consequence of these factors and others is that there are not nearly enough school leavers going into engineering and most of those who do get into management or research jobs as fast as they can. Few of them take up design as a career.

There are fourteen recommendations for action in the report. The list starts off with two general ones which concern impressing the engineering industry with the importance of design and the encouragement of talented engineers to make it their career on the one hand and getting across to the public the value of engineering in the national economy and the urgent need for more engineering designers on the other. It says that membership requirements for professional institutions might be altered to give more prominence to design qualifications. Many of the other recommendations are concerned with education and training. They include the arrangement of experiments in teaching design at undergraduate and post graduate levels, the reorganisation of the practical training of engineers with more emphasis on modern production methods and the influence of design and establishing institutes for advanced studies in design in close collaboration with industry as well as a higher degree in engineering design. Development contracts—some of which have been awarded by DSIR—should be used to encourage the creation of high quality design teams. These measures and the others put forward will take time, but a reading of the report leaves no doubt that there is no time to lose.

Why do we still get fatigue failures?

The breaking of materials under repeated applications of a load is a problem that is inherently complicated and research results can give only partial assistance to designers. Lack of attention to detail in either design or production must, however, be blamed for many catastrophic failures that occur

by C. E. Phillips and N. E. Frost
Materials Group, National Engineering Laboratory

MANY important breakdowns of plant and machinery which occur in service are caused by the fatigue failure of a metal part. As the phenomenon of metal fatigue has been known for over a hundred years and studied seriously for nearly half this time, it is pertinent, in view of the recently published Feilden Committee report on Engineering Design, to seek reasons for the continued occurrence of such failures.

The term "fatigue failure" refers to the breaking (or sometimes to the cracking) of a material by the repeated applications of a load; the material may be in the form of a complex structure, a machine component or merely a laboratory test specimen. The load which will cause failure when applied many times is much less than that required if applied only once, and is generally insufficient to produce visible distortion. The conditions under which material operates in service vary widely, and the frequency of the alternating component of load can be greater than 100 000 cycles per second or as low as once or twice per day. These wide differences are exemplified by a compressor blade vibrating at its natural frequency, the connecting-rods of a car engine, a railway bridge and an aircraft cabin which is pressurised during flight.

A metal, when machined and polished, is considered to have a fatigue strength that is an intrinsic property readily determined by laboratory experiment. The experimental techniques involved are rather more complex than those used for determining the common static strength properties of yield strength and tensile strength. For instance, because fatigue failure generally starts on the surface of the material (as will be discussed later) the effect of the metallurgical and mechanical condition of the surface is very pronounced; it is therefore essential that all specimens of a batch used to determine fatigue properties have comparable surfaces. Only the alternating component of a load leads to the initiation of a surface fatigue crack, and most available fatigue data have been accumulated under conditions of simple alternating load—that is, with zero mean load. However, fatigue performance can, where necessary, be determined under conditions of alternating bending, tension, torsion, or a combination of such loads, with or without a mean load, at normal or elevated temperature, at various speeds of load application, in air or a corrosive atmosphere, and with a particular surface condition related to the service requirements.

The Feilden Report on Engineering Design notes that the National Engineering Laboratory finds that neglect of fatigue is the basic cause of more than three-quarters of the failures in service that are referred to it.

The intrinsic fatigue properties of a material are obtained experimentally from a batch of identical specimens used to estimate the greatest stress-range that can be withstood with a negligible risk of failure occurring during an infinite number of cycles of stress, or such a number as represents a useful life of a particular component. For some materials there is a limiting stress range called the "fatigue limit" which will not cause failure however many times it is applied; other materials merely show a marked increase in the number of stress-cycles necessary to cause fatigue as the stress-range is decreased.

What happens when a cyclic stress causes a metal to fail? A brief and simplified answer is the following. Metallographic examination shows that fatigue damage usually begins in certain favourably oriented metal grains at a free surface (hence the importance of the precise condition of the surface—whether "as-forged", machined, polished, corroded, cold-rolled, etc.); relative movements occur within such surface grains and, after a comparatively short time, these sliding movements produce local surface roughening which becomes more accentuated as the number of applied stress cycles increases. The nucleation of minute surface grooves and fissures, or "micro-cracks", can be regarded simply as a continuation of this roughening process, and some adjacent micro-cracks eventually join together to form one larger crack which grows across the section to cause complete failure. Whilst the formation of surface micro-cracks arises from shearing effects of the applied stress, the growth of a macroscopic crack depends upon repeated opening and closing. In special circumstances, cracks may grow from sub-surface inclusions or defects but, in the majority of cases, failure starts in the surface grains of a material. A surface crack can usually form and grow under the influence of a cyclic stress which is insufficient to give rise to general plastic deformation, and therefore fatigue stresses usually result in a failure which has an overall appearance of brittleness.

Unfortunately, from the designer's viewpoint, the number of variables to be considered when the question of fatigue strength arises is large; the fatigue properties of all materials of engineering interest under all possible combinations of stress systems, surface finish, surface condition, heat-treatment, temperature, environment and speed of application of stress cycles are not and never will be available, and he must therefore estimate the particular fatigue performance he happens to be considering from whatever data there is to hand. Moreover, the intrinsic fatigue properties of a material provide him with only general guidance to the fatigue strength of a solid component and often have little relationship to the fatigue strength of a joint or structure made of the material. It is reasonable to assume that he can produce a satisfactory and efficient design for a component of uniform section which has to withstand fatigue loading provided that:

(a) the intrinsic fatigue properties of the material in the required size and condition are known with a sufficient background of information to indicate the variation in performance that is likely to occur between one component and another;

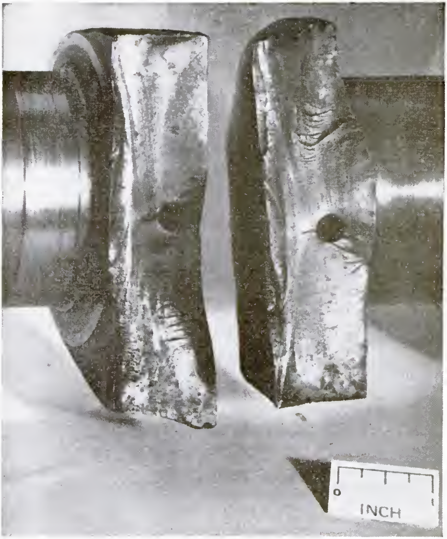
(b) the precise dynamic stresses to be withstood are known. This is rarely the case as dynamic stresses can be caused by many influences unknown to the designer vibration of nearby plant and exceptional operating conditions are examples;

(c) the dynamic stress cycles involved are of constant amplitude. However, the spectrum of loads to be endured almost always consists of stress cycles of varying amplitude and there is not, at present, any precise method for relating fatigue performance under such conditions to results of tests at constant stress amplitudes. To ensure that fatigue cracking will never occur, the best that the designer can do at present, unless extensive testing has been carried out under conditions corresponding to the service conditions, is to see that the maximum of the various stress amplitudes never exceeds the intrinsic fatigue strength of the material.

(d) the effect on the fatigue strength of the material of the precise environment in which the component is to operate is known. It has been amply demonstrated that small changes in environmental conditions, particularly if they are slightly corrosive, can have very marked effects on fatigue performance.

So we see that, even for the simplest of design problems, difficulties can arise which cannot be readily resolved. But very few components are of uniform shape; most contain discontinuities, in the form of changes of cross-section, grooves, welds, holes, etc., and any form of joint constitutes a most serious kind of discontinuity. Indeed, of all fatigue failures which occur in practice, most result from fatigue cracks originating at a discontinuity of one sort or another, and lack of attention to detail design in such regions is the greatest single factor responsible for the failures. The use of a general safety margin on the static strength of a material to guard against the effect of unknown high local stresses and unknown loading conditions is often satisfactory when the design only has to withstand static loads, but it is generally proved quite unsuitable when fatigue loading is involved. Moreover, even when a component has been adequately designed, it may fail in service without any reflection on the designer, because of unsatisfactory manufacture—for example, machining marks left on a highly stressed component, or a generally rough surface finish. Well-proportioned curves shown on working drawings do not always appear as such on the finished article, and inspection of such components before they pass into service is all too frequently related only to dimensions and functional behaviour; the question of whether or not its fatigue strength has been seriously reduced by unsuitable machining or altered production methods is overlooked.

Nowadays, experienced designers are mostly aware that violent changes of cross-section should be avoided whenever possible because they give rise to high local stresses that assume paramount importance under fatigue conditions. Changes of cross-section are obviously unavoidable, however, and although a vast amount of research has been spent on determining the fatigue properties of materials machined to contain various forms of discontinuities (holes, rounded notches, sharp notches, grooves) these data from laboratory tests are only of limited assistance to a designer.



Fatigue fracture in the web of an engine crankshaft originating at the junction of the web and the journal.

The extent to which a discontinuity or change of section gives rise to a high local stress can be demonstrated mathematically in a few simple cases; special techniques, especially that of photo-elasticity, in which transparent plastic models reveal stresses by their effects on polarised light, can be used to evaluate other cases by direct experimentation. The existence of a high local stress does not necessarily cause a serious loss of strength under steady load conditions because, for the normally ductile engineering materials, local plastic deformation can be tolerated. Failure will not occur unless the stress is high enough to cause deformation right across the section. But, when the loading is of a cyclic nature, fatigue cracks will form when the *local* stress amplitude is just greater than the intrinsic fatigue limit of the material—usually less than half the tensile strength. At this stress level, the bulk of the material is still elastic, and elastic stress theory can be used to evaluate the maximum local stress amplitudes occurring.

So, in designing a component to withstand fatigue loading, it is necessary to assess the value of the local stress intensification in the vicinity of important changes of section. But, when this assessment has been made, information in the literature on the effects of high local stresses on fatigue performance cannot always be directly applied. Much laboratory test in-

Why do we still get fatigue failures? *continued*

formation purports to show that local stresses higher than the intrinsic fatigue limit can be tolerated without fracture occurring, and much effort has been expended in attempts to establish relationships which would enable a designer to predict the performance of untested shapes. Many of these relationships are of doubtful value to the designer, and can be misleading where the local stress intensification is particularly severe for, in such cases, small cracks can form although they may not propagate to cause complete failure under the application of fatigue stresses of constant amplitude. The existence of such small cracks would not, in general, be acceptable to a designer, because under service conditions occasional high loads might well cause them to grow.

Studies of fatigue crack growth show that, under simple conditions, the rate of growth is proportional to the crack length (l) and the cube of the alternating stress (σ) and that there is a limiting value of $\sigma^3 l$ below which crack growth does not occur. This limiting value is the same for mild steel (30 tons per sq. in. tensile strength) as for an alloy steel (70 tons per sq. in. tensile strength) but varies widely for other materials. This explains why certain notches of the same size result in the same fatigue strength for each of the above types of steel, even though cracks would form at the bottom of the notch in mild steel at nominal stresses less than half those required in the case of the alloy steel, and illustrates the dangers that can arise from the assessment of materials by a "notch-sensitivity index".

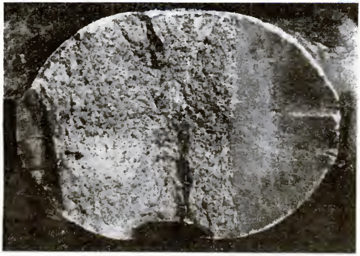
So far, consideration has been given mainly to solid components. In joints and built-up structures generally, the problem of stress-distribution is much more complicated. Uniform distribution of load amongst the various members is seldom achieved in practice, and the precise stress-distribution likely to occur in a joint is seldom amenable to mathematical treatment or experimental techniques. Recourse to the testing of full-scale samples is desirable if detailed fatigue design data are required, although small-scale testing can often provide useful guidance. The intrinsic fatigue properties of a material often give but little information regarding the fatigue strength of a joint made from that material. Large complex static structures are often such that the important stresses are those arising from the weight of the structure whilst any superimposed dynamic stresses are of relatively low magnitude; should fatigue cracks form under these conditions they would have a very slow rate of growth. Various examples could be quoted where small fatigue cracks are known to exist in service without necessarily leading to overall failure, but these cases are not common and usually occur when high local compressive stresses are present.

Of the many extraneous factors which have a profound influence on the fatigue strength of composite components, perhaps the most important is "fretting". Fretting damage occurs when small relative tangential movements (~0.01 mm) occur between surfaces held in contact under pressure. Such movements occur in many forms of joint and may reduce the fatigue strength of a joint to an astonishingly low value, particularly when the materials involved are light alloys and high-strength steels. Comprehensive studies of these effects are of comparatively recent origin and no general guidance is available to designers when dealing with them; various palliative measures are available but it cannot be guaranteed that they will always be effective.

In spite of all the difficulties outlined above, many successful designs of very complicated machinery are, of course, produced. Only too often, however, when failure does occur, the overall functional demands have been adequately met, but a whole catastrophe results from inattention to a detail not apparently of immediate concern with functional performance of the complete unit. For most products the ability to perform a particular function is the main selling potential. While the main conception of a large design project lies in the hands of an experienced and responsible staff, the detailed drawing of minor parts often devolves upon juniors. The disadvantage of this apparently natural arrangement can now be seen, because a lack of knowledge of the effect of stress-distribution on fatigue strength or a lack of appreciation of the many ways in which the performance of a material in service can be detrimentally affected, can have very serious consequences; indeed, these consequences may often seem to be out of all proportion to their cause.

Nevertheless, wherever the onus of responsibility lies, there are undoubtedly too many failures occurring in service because of lack of attention to what, in these days, should be regarded as elementary features of design practice. Serious breakdowns which are still happening can all too often be traced to unnecessarily sharp changes of cross-section, to grooves that extend further than they need do, to retaining-ring grooves that are machined sharp and deep, to holes drilled in areas of high stress, or to badly finished welded joints. Although the inexperience of a junior draughtsman may be involved in the first place it is inexcusable that many malpractices should not be rectified before the production stage is reached. It must also be re-emphasised that good design can all too easily be vitiated by inappropriate production methods which lead to profiles other than those intended by the designer or to poor surface finishes in critical areas, and collaboration between the design and production teams is not always as close as it should be. The use of special techniques to improve fatigue strength, especially the cold-rolling or shot-peening of highly stressed areas, is not so commonly demanded by designers in Britain as would be expected from the research effort devoted to their study.

This leads us to reflect, as the Feilden Committee has done, not only on the subject matter taught in "strength of materials" courses at many of the higher educational institutions from which our designers in industry are drawn, but also on the status in industry generally attained by designers.



Fatigue failure of the front axle of a light goods vehicle. This photograph of the fracture surface shows that the fatigue crack was initiated in the forged surface and extended one third of the way across the section before failure occurred.

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Nature's other greens

Apart from chlorophyll, which dominates the natural scene, there are several other green pigments. The structure of one of them, xylindein, produced by a fungus that grows on dead wood, has recently been elucidated; it turns out to be quite different from that of chlorophyll

by Dr G. M. Blackburn
University Chemical Laboratory, Cambridge

This article deals with a subject discussed at the International Congress of Pure and Applied Chemistry in London that ended last week. A paper entitled "The structure of xylindein," by G. M. Blackburn, A. H. Neilson and Lord Todd, was presented by Dr Blackburn.

THE abundance of the chlorophylls, the green leaf-pigment of plants, is so overwhelming that it almost becomes excusable to suppose that they uniquely provide green colour in nature. It is not so. Nature has other green pigments. Of those which bear some resemblance to the chlorophylls, the green bile pigment, biliverdin, is the best example: Figure 1 shows the similarity. Biliverdin is formed by biological degradation of the red blood pigment hemin and, in addition to bile, it colours such diverse objects as the placentas of dogs and egg-shells of birds.

There are other natural green pigments that are not related in any way to the chlorophylls but are members of the third most numerous class of natural pigments—the quinones. These are less prolific than either the carotenoids (typified by the red-orange of carrots) or the melanins. And although the quinone pigments are distributed widely through nature, their colourful contribution is small because they are often located in micro-organisms or in the bark and roots of trees. Only those in the higher fungi and lichens catch the eye, and then mostly with yellows, reds, and a few purples. Of the greens, we should not count the green of the sea-urchins, which is composed of green calcium salts of reddish polyhydroxynaphthoquinones. Few are genuinely green. Two of these few, lo-kao and xylindein, have had commercial prospects, only to pass from interest with the advent of synthetic green pigments.

Lo-kao was used by the Chinese to dye silk and cotton a beautiful bluish-green. Stimulated by the high cost of the dye (224 francs per kilo), scientific study began in 1852 on a 1-g. sample of pigment sent by the American Consul in Canton to Persoz. Later information from missionary sources revealed that the green colour could be obtained by repeated dipping of silk in a colourless alkaline extract of broom followed by exposure to sunlight. The native plants "Hong pi lo chou" and "Pé pi lo chou" were identified as *Rhamnus chlorophorus* and *R. utilis* respectively. As the latter was also found in France, interest transferred from the green material to the active colourless component of the alkaline extract.

Xylindein has a longer scientific history. The greenness in dead wood caused by the fungus *Peziza aeruginosa*, now known as *Chlorociboria aeruginosa*, was the object of scientific discussion as long ago as 1728. But the pigment responsible for the colour was only obtained in crystalline form in 1874 by Liebermann, who showed it to be a quinone. It was noticed that the dead wood which had been permeated by the coloured mycelium of the fungus was unaltered in texture and resisted decay. This green wood was used decoratively in Tunbridge ware, in which composite veneers were prepared from differently coloured woods, and a process was patented for the artificial colouring of wood with *Chlorociboria*.

In the determination of structure of a large quinonoid molecule, the investigation proceeds along three lines. It is necessary first to recognise the functional groups in the molecule so that its chemical manipulation can be understood, secondly to identify the major skeleton of the molecule, and thirdly to locate the functional groups

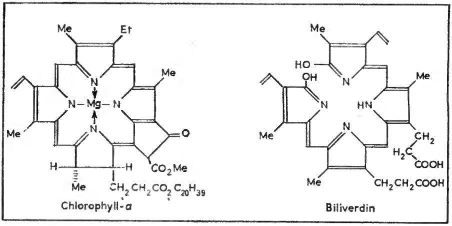
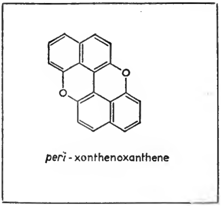


FIGURE 1. *The chlorophylls, typified by a chlorophyll-a (left) are nature's most important greens—indeed, her most important pigments, because of their role in trapping the energy of sunlight for the growth of plants. The green bile-pigment, biliverdin (right) is one of the other natural greens and is closely related to the chlorophylls.*



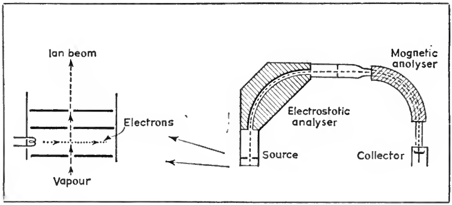


FIGURE 2. (*Above, left*). *When xylindein, the green pigment found in dead wood, is broken down chemically, one fragment is this* peri-*xanthenoxanthene, which is a yellow material and provides the clue to the green of the parent molecule.* FIGURE 3 (*right*). *The mass spectrometer, which affords determinations of molecular weights to one part in 100,000.*

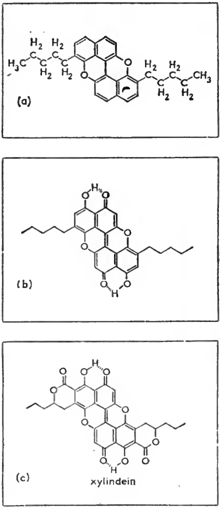


FIGURE 4. *Steps in the elucidation of the structure of xylindein: (a) fragmentation by mass spectrometry reveals the presence of two side chains* C_5H_{11} *on the* peri-*xanthenoxanthene nucleus; (b) spectroscopic evidence points to the presence of the OH . . . O bridges; (c) other evidence from degradation allows the completion of a pair of lactone rings.*

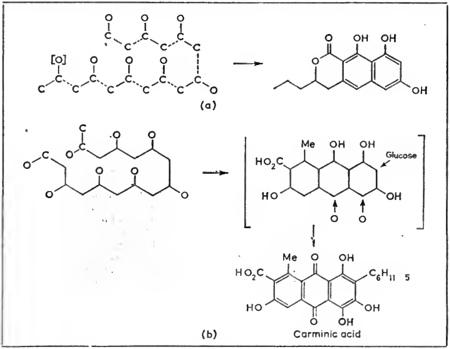


FIGURE 5. *The xylindein molecule can be visualised as being composed of two identical parts built up from eight 2-carbon units, as in (a). If this 16-carbon unit is folded in a different way, it can lead to carminic acid (b), the coloured principle of cochineal.*

on it. The first of these objectives was investigated by Fritz Kögl in the late 1920s with moderate success; he failed, however, to gain any knowledge of the skeleton other than a tentative identification of phenanthrene as a product of one degradation .

So when we began work on it in Cambridge the dominant question was "What is the chromophore of xylindein?" It is the nature of the chromophore of dyes and pigments which, augmented by the peripheral functional groups, governs the absorption of light energy by electrons whose orbitals extend across the molecule (see "Electrons in molecules" by Professor H. C. Longuet-Higgins, 14 March). The non-absorbed light determines colour. In spite of recent advances in spectroscopy it was impossible to find a relation between the visible and ultraviolet absorption spectra of xylindein or its simple derivatives and those of known aromatic nuclei. So we needed a less complex, large fragment of the molecule.

The classical method of obtaining such a fragment is to deoxygenate the molecule by distillation with zinc powder in a melt of sodium and zinc chlorides. It looks, and is, very crude; but it worked. Our fragment was a yellow, crystalline material. Its ultraviolet spectrum showed it to be a *peri*-xanthenoxanthene (Figure 2), and further comparisons showed this skeleton almost certainly existed in xylindein as well. Here

Nature's other greens *continued*

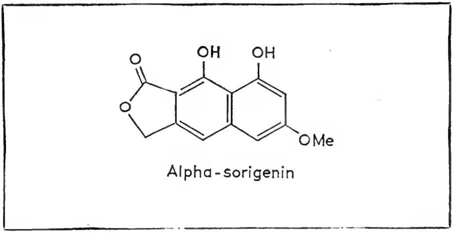


FIGURE 6. *Another natural product, alpha-sorigenin, found in a species of broom, shows some similarity to the xylindein precursor of Figure 5. This in turn is probably closely related to lo-kao.*

was the clue to the green colour. Xylindein had a chromophore similar to those of many of the synthetic dyestuffs. However, we needed more information and, as the fragment was only available in milligramme quantities, we resorted to mass spectrometry. Dr J. H. Beynon of ICI Dyestuffs Division kindly undertook this work for us.

A mass spectrometer is a device for measuring the masses (strictly, the mass: charge ratios) and relative abundances of positively charged ions. The vapour of the sample to be studied is bombarded with a beam of low energy electrons in a vacuum system (Figure 3). An electron striking a molecule tends to knock another electron out of it, producing a positive ion, but it often breaks chemical bonds, so that a charged fragment of the original molecule is produced. The positive ions are then accelerated by a high voltage and emerge from the ion in a fine beam. They are then subjected to the deflecting and focusing action of electrostatic and magnetic analysers: in general, the heavier ions are deflected less readily than the lighter ions. By varying the magnetic field the device directs one mass after another into a collector, and the signal obtained is amplified and recorded.

For the organic chemist the technique provides information of two types, the one precise, concerning the molecular weights of the parent and fragment ions, the other empirical, about the pattern of fragmentation involved. All this from a sample of less than a milligramme!

The possibility of measuring masses to an accuracy of 1 in 100 000 allows an actual molecular formula to be assigned to the parent ion. In the case of our xylindein, fragment, the measured molecular ion of mass 422.223 ±0.004 fits only the formula $C_{30}H_{30}O_2$ (mass 422.224) and not $C_{31}H_{34}O$ (mass 422.261) nor $C_{32}H_{38}$ (mass 422.297).

Information about the structure of the molecule comes from collation of the fragments also recorded in the mass spectrometer. One of the best-known fragmentation processes involves the cleavage of the side chain at the carbon-carbon bond next but one to the aromatic system. This is recognised in the mass spectrum on finding a strong peak having the mass of the parent ion diminished by the mass of C_nH_{2n+1}. We found two such peaks in our spectrum corresponding to reductions of the parent mass by 57 and 114, or to the removal of one and two C_4H_9 groups respectively. From this result we can deduce that there are two five-carbon side chains on a $C_{20}H_8O_2$ nucleus. More complex deductions showed that they were unbranched and probably located as shown in Figure 4a.

When this structure was confirmed by synthesis, Kögl's molecular formula for xylindein, $C_{34}H_{26}O_{11}$, showed that we had only four carbon and nine oxygen atoms still to locate. Many of these fell rapidly into place by tacking on the functional groups. First, the quinone chromophore itself could now be recognised by comparison of spectra with that of the parent quinone. This, by one of those queer strokes of luck, had been synthesised unambiguously by Pummerer in 1933. Two hydroxyl (OH) groups had to be located as shown in Figure 4b, so as to provide six-membered rings containing a hydrogen bridging two oxygen atoms: this feature has been deduced from characteristic spectroscopic evidence.

The remaining functional groups comprised two six-membered lactone (C_3H_3O) rings. Since other evidence from oxidative degradation suggested that the five-carbon side chains had oxygen atoms attached to the carbon next but one to the ring, we could use up two of the "spare" carbons and four oxygens to give us the complete structure (Figure 4c).

This differed from Kögl's formula by a fragment C_2H_2O for which we had no other evidence, and the structure of Figure 4c appeared to be capable of explaining all the chemistry of xylindein. Did the fragment really exist?

There is often a certain amount of doubt about the correctness of big formulae. The percentages of carbon, hydrogen, and oxygen in the molecule determined by combustion analyses can only be found within experimental limits capable of encompassing several formulae. Only the mass spectrometer or careful X-ray determinations provide a molecular weight accurate enough to determine a unique formula in conjunction with analytical data. We thought it almost impossible to volatilise a molecule as big as xylindein into the electron beam.

We had underestimated the ability of the specialist mass spectrometer. When xylindein was cooked up at 400°C a spectrum was produced in which the predominant parent ion corresponded to the formula $C_{32}H_{24}O_{10}$ of our structure (Figure 4c) but also showed the presence of other molecules in much smaller amounts with one or two carbon atoms more. We had not expected to find that xylindein was the major component of a series of homologous compounds!

We can speculate on how the fungus produces the pigment. While little is known of the function of the majority of the quinone pigments, it seems possible that they arise as an "overflow" of fatty acid metabolism when the enzymes concerned become overloaded. The xylindein molecule can be visualised as two identical parts which can be built up from eight two-carbon units (Figure 5a). However, speculation does not answer the question of how the halves are joined. That must be decided by experimentation.

This sixteen-carbon unit is quite common. If, for instance, it is folded in a different way, it can be seen as a precursor or carminic acid, the coloured principle of cochineal (Figure 5b). Materials of the general chemical type of xylindein are unusual and rare metabolites and it is, therefore, surprising to find that a similar one, alpha-sorigenin (Figure 6), is found in *Rhamnus japonica*. According to early work in the field, this species does not give rise to Lo-kao. But it is amusing to speculate that *R. utilis*, the source of Lo-kao, might contain a related metabolite, and that the chemical that the Chinese wrought by sunlight, *Chlorociboria* effects in the dark!

At the University Chemical Laboratory in Cambridge we have also been investigating another of nature's green pigments—the green colour of aphids. But that is another story, not yet quite ready to be told.

American Newsletter

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by GEMINUS

NEW YORK

JUST BEFORE my return to Britain, I must record my regret at what seems to me to be a bad decline in the spirit, and even the quality, of science. Though I have spent the last year working at one of the most reputable institutions in North America, I have found the experience quite disillusioning. It has been sad to see, from the inside as it were, how ready even distinguished people can be to win some cheap (and perhaps misleading) publicity by a properly timed newspaper story (and how ready they are, after the event, to pretend that they have been taken for a ride by a ruthless reporter); it is alarming to see how many papers are published in the journals merely as a rehash of some previously published piece of work; it is sad to see how much creative energy now goes into the polishing of applications for grants from public funds; it is appalling that people can be so ready to do each other down, or to win the patronage of those powerful creatures who staff the committees in Washington; it is upsetting to see how mean people can be to each other in the frightful competition for priority, or for popularity, at scientific meetings.

Simply to recite examples like this, of course, is in itself no proof that science has gone to the dogs. It is wrong to expect that scientists should be indifferent to self-interest, or to suppose that they have ever been so. Yet it does seem to me that, when I visited this country first, in 1956, these tendencies were powerfully restrained by the old traditions of the academic world. Just as the selfish excesses of the mediaeval monasteries were kept within bounds of some kind by such things as the fear of Eternal Damnation, so latter-day monks seemed to be kept more or less on the straight and narrow path by the wish that whatever they did should be academically respectable. In my opinion this is now much less obvious a restraining force. I should add that this opinion is not based on a casual acquaintance with American science; I have spent no less than a quarter of the last six years on this side of the Atlantic.

What, then, has changed? Why has it become so commonly the case that personal success in science has come to demand the qualities traditionally thought necessary for success in selling vacuum cleaners? To my mind the most important single cause of the trend over the last few years is that it has become too easy to win financial support for research projects. I am not complaining that the amounts of money being spent are in themselves excessive, but that they are being distributed indiscriminately. During the tests to which grant applications are subjected in those cool offices in Washington, nobody seems to inquire too rigorously as to whether the work proposed will add to the general body of scientific scholarship. The result is that similar projects are supported at a host of different institutions, simply because all their authors fancy themselves dolled up in white tie and tails, and delivering themselves of a Nobel address to an audience that includes the Swedish royal family. Then there are some names that cannot be refused, however nebulous their requests might be. Often, too, it seems that grant-giving committees have handed out largesse with geographical considerations chiefly in mind, presumably so as to disarm the senator or congressman who asks, "What are you doing for science in the state of North Dakota?"

Geminus will be on holiday until September, when he will resume his contributions from London under the title *It seems to me*. From now on, *American Newsletter* will be written by Howard Simons of the *Washington Post*.

★

TO USE THE WORD *corruption* for this state of affairs does not seem to me to be extravagant. For one thing, there has grown up a great confusion inside the laboratories as well as out, about the real function of science in the civilised world. Is it meant to make people prosperous? Or to keep them (and especially congressmen) alive forever? Or is science, as some would say, the only way to win respect in the modern world? Or, at least, the only way to win the Cold War?

Then again, is it a kind of public works programme, designed to bring prosperity to areas. and to groups, who might otherwise be unemployed? Or is it "progress", whatever that may be? Or is science a part of that continuing intellectual activity by which men (humanists as well as scientists) have sought to become wiser? In my experience of the last year, there are very few scientists prepared to stop to consider this question.

In practical terms these tendencies are an evil influence on university teaching. The people who ought to be the backbone of university teaching are often so busy travelling to Washington that they have no time for such humdrum tasks. An undergraduate is valued for his potential usefulness as a research assistant. No attention is paid to the doctrine (for which there is much to be said) that the chief practical value of scientific research is to serve as a vehicle for university teaching. The Congress which supports the spending of money on research has set its face against anything that might smack of support for education as such.

Though the immediate effects of this state of affairs are most damaging in the United States, it is inevitable that there should be difficulties elsewhere as well. For one thing, the indiscriminate openhandedness of support for American science is tempting people from abroad in a perpetual stream. This, and not a deliberate parasitism, is what Lord Hailsham should have complained of earlier this year. One of the most unhappy features of the immigration of scientists to the United States is that people who have a great deal to contribute to university teaching at all levels are instead incarcerated in the overheated world of laboratories and committees.

★

IN THE LONG RUN, more serious things are likely to follow from the principle that even bad science is international. For how long will the still comparatively ascetic centres of learning in Europe be able to resist the new fashion? In the debasement of science as of money, it is likely there is a kind of Gresham's Law. Given time, the bad is likely to drive out the good. In the end we may all suffer.

To those who consider this comment to be too jaundiced a valediction to a country which is at once admirable and exhilarating, my defence is that the only cure for the kinds of evils that I fear is public comment, but in a much more insistent way than this. To those of my friends who protest, "But you can't mean me!" I must add the obvious and necessary qualification that there is a host of people here whose work is admirable in every kind of way. Yet, I regret to say, my friends are not notable for their asceticism. To those who protest that I am anti-American (which I am not), I can only reply that the too ready assumption that everything is always for the best is one of this country's most common failings.

Science in British Industry

Making malt "in a street"

IN THE Wanderhaufen moving batch malting system—a mechanised process of Austrian origin, new to this country, recently installed by R. and W. Paul Limited in their Ipswich maltings—the huge machine plays a key role. As it travels on rails mounted on top of the side walls of the 125-foot long "street" in which the moist grain is germinated, it scoops up and meticulously inverts the 3 ft-deep layer of grain; simultaneously, it shifts this "green" malt, day by day, towards the kilns.

A new batch of steeped grain is gravity-fed each day into the space left in the street after the previous batch has been moved forward. Rapid and even germination is achieved by this careful turning, aided by the cool, moist air ducted into the grain through perforations in the street's floor.

With the operating conditions governed by the results of micro-malting tests made on each fresh batch of barley, the Wanderhaufen process combines close quality control with rapid malting. Malt destined for lager production is ready for kilning after only five days; malt for English ale requires eight days' germination.

Production line for cabbages

THE DEVELOPMENT of the F1 hybrid cabbage, which produces uniformly buxom plants, each a replica of its neighbour (see photograph), has brought the market gardener a welcome opportunity to streamline his cabbage-growing operations. Since all the plants in a crop of hybrid cabbages reach maturity at the same time, sowing and harvesting can proceed systematically, strip by strip, down the field. This is simpler and much less laborious than the present practice of sowing the whole area with an ordinary variety of cabbage, and then, because of the plants' notoriously variable growth, at intervals making forays into the field to cut those that are ready for market.

Apart from the damage to soil structure likely to result from so much traffic, the traditional method of cabbage growing entails keeping the whole field out of commission until the plants that mature the slowest have been harvested. Strip cultivation with F1 hybrids would permit more intensive use of the land, for each newly cleared trip could be replanted at once with the following crop.

This year, after field testing a number of Japanese-bred hybrid cabbages, Hurst, Gunson, Cooper, Tabor Limited, who are seedsmen with extensive trial grounds and a plant-breeding unit in Essex, have introduced five of these F1 varieties into this country; four are for human consumption, and one is for cattle.

These magnificently uniform specimens are "Summer Monarch" F1 hybrid cabbages.

Not all amateur gardeners will feel enthusiasm for the F1s' trait of simultaneous maturity, which suggests a certain monotony of diet. But for those who like "greens", a few seeds of the appropriate hybrid, sown at strategically spaced intervals of time, should simplify the cabbage supply problem—and will certainly enhance the appearance of the kitchen garden.

Radio transmits the strain

A RADIO TRANSMITTER that operates under loads up to 40 000 times its own weight and at temperatures up to 125°C has been developed by Mr S. A. Andrews in the Electro-Dynamics Department at Bristol Siddeley Engines, Filton, Bristol, to transmit information from strain gauges attached to the blades of gas turbines. With this system it is possible to transmit simultaneously, on three or four transmitter channels, the signals from the strain gauges.

On modern aircraft gas turbines, designed with low- and high-pressure compression sections, it has been extremely difficult in the past to obtain measurements of this type on a full-scale engine from the rotating high-pressure spool of the compressor. The application of radio transmitters in this field will enable the measurement of stress from turbines and compressors while these are operating at full power conditions.

The basic problems which had to be tackled could broadly be reduced to three: supply of power to the transmitter and strain gauges, and the transmission and detection of signals. It was important to keep the transmitter small because of the severe limitations on space inside a gas turbine. For this and other reasons frequency modulation on centre frequencies in the 50 to 100 megacycles a second band, using a 5 megacycle spacing between channels, was chosen.

The aerial of the transmitters is closely coupled and this, together with its enclosure by the engine casing prevents random transmission which otherwise could interfere with other receivers tuned to the same frequency. Power is coupled into the rotating assembly inductively by using a radio frequency power source, the frequency of which is chosen to ensure that harmonics do not coincide with the rotating transmitter frequencies. A bridge rectifier with smoothing and voltage limiting provides the d.c. supply to transmitters and a polarising voltage to the strain gauges.

By using transistors in the switching circuit it is possible to select, in a predetermined sequence, a number of different strain gauges through the various transmitter channels and also to provide a calibration reference.

An overall system accuracy of better than ±10 per cent has been achieved without the use of a calibration reference on the rotor, but use of the latter will bring the accuracy to better than ±2 per cent.

The corrosive waters of the River Thames

IT HAS—quite reasonably—been suggested that pollution of estuary waters by sewage and industrial wastes may cause immersed metalwork to suffer a rate of corrosion far greater than it suffers in fresh water or in the open sea. Evidence adduced from examining barges and structural steelwork suggests that this is so, but until recently no systematic investigation had been carried out. The National Chemical Laboratory, Teddington, with the cooperation of the London County Council, the Port of London Authority and the Water Pollution Research Laboratory, has now begun a five-year programme to investigate the corrosion of mild steel in the lower reaches of the Thames, the first year's results of which have just been published.

The results so far obtained by Dr G. H. Booth, A. W. Cooper and A. K. Tiller show irregularities and isolated abnormalities that make a precise interpretation difficult; but some trends can be discerned. The lower corrosion rates occur in the Richmond-Putney area; there is then an increase to a maximum in the region Woolwich-Crossness-Rainham, followed by a fall at Tilbury, and a further rise at Southend to about the same corrosiveness as the up-stream maximum.

Mild steel plates are being tested under four conditions of exposure—full immersion, half immersion, tidal immersion and immersion in mud—at nine sites between

Richmond and the sea. The team had hoped to carry out control tests in an unpolluted tidal estuary, and it is a sad reflection upon our lack of control of industrial pollution that a suitable estuary could not be found in the south of England; arrangements are in hand for tests in the relatively unpolluted estuary of the Dovey, in mid-Wales.

The trends in corrosiveness so far revealed can be explained as a combination of two influences: first, the increase in chloride concentration as one proceeds downstream, resulting in an increase in aerobic corrosion. Secondly, a decrease in oxygen concentration from Richmond to Woolwich-Crossness-Rainham, followed by an increase to Southend. The latter would give a maximum anaerobic (or bacterial) corrosion in the Woolwich-Crossness-Rainham stretch. The relative importance of these two types of corrosion cannot be assessed until tests have been completed in the unpolluted estuary to determine the effect of changes in salinity when the oxygen concentration is constant.

Iodine saves the strawberries

TESTS REPORTED by L. N. Staniland of the National Agricultural Advisory Service, Bristol, suggest that an iodine dip may be useful for protecting strawberry plants against the virus disease, arabis mosaic, for which the dagger nematode *Xiphenema diversicaudatum* is known to be a vector. Strawberry runners were unaffected by concentrations of iodine that proved lethal to the nematodes.

One minute's immersion in a dilute solution of iodine—1 part in 4000—rapidly immobilised the creatures, and no signs of recovery were observed even when they were transferred to clean water and watched for a week. But four varieties of strawberry, Favourite, Talisman, Cambridge 141 and Surprise, planted out after being root-dipped for 10 seconds, or totally immersed for one minute in iodine solution, subsequently grew and fruited well—even when treated with an iodine solution twice as strong as that used on the nematodes. The plants obtained from the treated runners were indistinguishable from untreated controls.

In brief . . .

"DRY-CLEANING" EGGS—preferable to washing, for this impairs their keeping quality—has proved a surprisingly difficult operation to merchandise satisfactorily, and in solving the problem with a sand-blasting technique, two Shrewsbury firms, Hartley Electromotives and Salopian Industries-Metals, have carried off the British Egg Marketing Board's long-standing £1000 prize and a silver medal presented by the Royal Agricultural Society. The egg dry-cleaner processes 1500 eggs an hour by bombarding them with an air jet loaded with abrasive powder as they travel through the machine on a conveyer; each egg is rotated so that its surface is fully exposed to the cleansing blast.

Heat-treating steel by electrolysis

EXPERIMENTS in the heat-treatment of steel strip by an electrochemical process have been pursued by Dr C. Watts at the Sketty Hall, Swansea, Laboratories of the British Iron and Steel Research Association for the last six months. This is a long-range research project with interesting possibilities as a "bright-annealing" process for stainless and other comparatively expensive steels, in strip or wire form. It could also be the way to sinter powdered metal coatings on a strip—or even to sinter a strip of metal rolled wholly from powder.

Electrochemical heat-treatment has been reported by Russian workers in, for instance, a tractor works to harden steel components. The technique adopted by the BISRA researchers has been to pass a very heavy current between two carbon electrodes immersed in an electrically-conducting solution, between which travels a 1 in.-wide steel strip at about 8ft a minute. The electrolyte they use is a solution of sodium carbonate. An alternating current at some 440 volts produces a current density of about 5 amp per sq cm at the surface of the strip, creating a stable gas film, mainly of hydrogen and water vapour, on its surface. The high voltage causes arcing of the current through this protective gas layer, and through the strip, which can heat the metal very rapidly up to and beyond its melting point.

The advantages incurred with such a technique include the protection afforded by the gas film, which would avoid oxidation of the metal surface and the subsequent problems this raises. The heating process is also very rapid; and the hot metal is very rapidly quenched or cooled by the electrolyte itself as soon as it leaves the influence of the electrodes. Moreover, since there is no direct electrical contact made with the strip, as there is in resistance heating, there is no risk of spark erosion occurring.

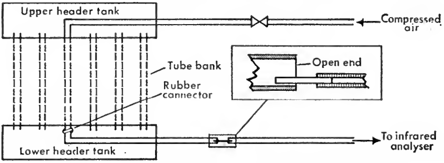
One advantage mooted but not yet realised is that of the uniformity of heating. The trouble lies, it is thought, with the use of alternating current; it needs at least 200 volts to create a stable gas film, and for much of the duration of the a.c. cycle the voltage is too low to support this condition. The researchers hope for better results using d.c. obtained from a commutator. A further problem that will arise in scaling the process up will be the need to remove the considerable heat generated in the electrolyte, which will probably help restrict the technique to the more expensive metals.

Locating a leak between gas and steam

RISK OF WATER VAPOUR from a heat-exchanger getting into the carbon dioxide which serves as coolant in a gas-cooled reactor has been recognised from the start in designing reactors like that at Calder Hall and an infrared gas analyser was fitted in the gas circuit to detect the presence of water vapour. Whenever an indication of water arose there was a shut-down. The defective bank of tubes was identified by testing for carbon dioxide in the vapour of the header tanks, and then a search was made for the actual tube in that bank from which the leakage was taking place. A much quicker method of finding the leak has now been developed at the Chapelcross works of the Atomic Energy Authority.

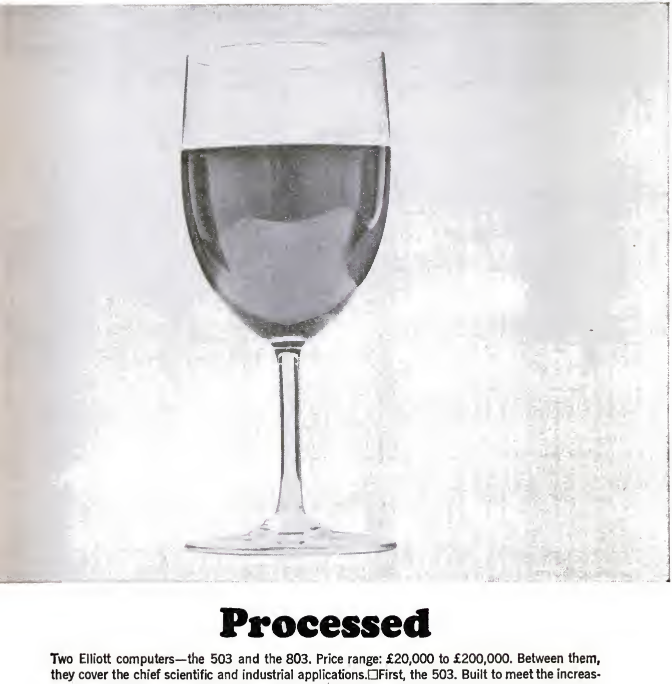
This method involves the use of a pipe which can be fitted on to the end of every tube in the affected bank, through which is drawn a sample for passing to the gas analyser, so that it may be tested for carbon dioxide. Whereas, under the old method, a shut-down of 24 hours might be necessary, the location of a leak and its subsequent repair or replacement can usually be done in a few hours by this method. The saving is purely in respect of time and the efficiency of maintenance. Care has always been taken to keep water out of the gas circuit, both to prevent corrosion and also to avoid any diminution in the effectiveness of the carbon dioxide as a coolant.

For the new method of detection a probe has been devised. It consists of a 12-ft length of ¼-in. conduit passing from one header tank to the other, with a special rubber connector for attachment to the heat-exchanger tubes and a sampling pipe leading to the gas analyser. At the upper end of the conduit, there is a connection with an air compressor for purging the pipe. After the purge the probing circuit is joined up. In this way, each section of steam tubing is tested in succession.



Construction and placing of the special probe that samples the steam.

Data...



Processed

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Science in Overseas Industry

HOLLAND

Television keeps the traffic moving

EINDHOVEN, the country's fifth largest town with a population of some 170 000, has an especially acute traffic problem, for no commensurate expansion of its town centre has accompanied the very rapid growth of its industry and population this century. One company alone, NV Philips Gloeilampenfabrieken, employs some 40 000 in the town. But an experiment in traffic control with the aid of closed-circuit television, carried out over the last eight months, promises to alleviate the congestion very successfully.

As long ago as 1957 a demonstration of television for the control of traffic was made to the First International Congress of Traffic Policemen, in Eindhoven; on this occasion, however, pictures were sent through a normal transmitter. The current experiments employ up to 22 closed-circuit television cameras to provide the traffic control office—at the police headquarters—with information from which it can assess traffic conditions and manipulate a linked traffic light system.

Cameras are placed at three main intersections in the town, while a total of ten important intersections have their lights linked together in a circuit which can be controlled from the central office. This system enables the police to keep the traffic flowing around the town centre, along either a west-east or an east-west route, on the "green wave" principle—which aims to keep it flowing smoothly and steadily through the lights. This principle requires a flow of accurate information about traffic movements into the central office, since congestion at any one of the intersections will affect the flow through the others.

These experiments are the outcome of collaboration between Mr D. M. De Jaeger, Chief of the Traffic Police Department, and NV Philips. Three types of television camera are employed: one is a "pan-and-tilt" type, remotely controlled and capable of revolving a full 360 degrees; it is equipped with a zoom lens that provides a clear view of the traffic for up to 100 metres. The other two types are fixed; one is equipped with an extremely sensitive lens that compensates for changes in the amount of daylight and can provide clear pictures under artificial light. The other is used in a battery of three at one important intersection on the town's "inner circle"; they provide information not only about activity at the junction itself but in the three approaches, too.

The combination of linked traffic lights and closed-circuit television has also been demonstrated in Munich and Frankfurt-am-Main; in the latter city the lights are reported to be adjusted anything up to 800 times a day to compensate for changing traffic flow. Amsterdam, too, is to experiment with a similar system; tests there have shown that it can save motorists 20 minutes in the rush hour.

UNITED STATES

Bacteria to make a packaging film?

IT HAS BEEN known since 1927 that a polymer, poly-beta-hydroxybutyrate, is formed by some types of bacteria. The original discovery was made by a French chemist, M. Lemoigne. Chemists headed by J. N. Baptist and F. X. Werber at the W. R. Grace and Company's Washington Research Center have recently been investigating the material and assessing its commercial potentiality and think it may find one commercial outlet—as a packaging film.

The polymer is a thermoplastic which can be melted and moulded. Unfortunately, its main drawback is a relatively low melting point of 178°C, a few degrees above which degradation to crotonic acid takes place. It is present as small crystalline particles in the cellular material of the bacteria and its formation is favoured by a nutrient medium of high carbohydrate and low nitrogen content. It can constitute up to 80 per cent of the dry weight of the bacterial cell.

The polymer is extracted from acetone-treated cells with pyridine or chloroform, and its molecular weight depends on the conditions of isolation.

The authors conclude that the process could be operated commercially and the product, in the form of a film, used as a cheap packaging material. No other specific use has been found for it, however, and it is likely that its commercial interest would be greatest in a country with an undeveloped plastics industry.

Rocket ahoy!

THE LAUNCHING of space vehicles from the sea is a project which has been worked out and studied by John Draim and Charles Stalzer, who have recently been granted a patent on their approach. The main object is to reduce the colossal costs involved in launching spacecraft into orbit or on deep-space missions by current methods. If the vehicles could be launched from the sea, much of the elaborate equipment used at present, including huge steel gantries mounted on large launching pads, could presumably be dispensed with.

The orginators of this water-launching plan make another claim—that it would remove the risks to personnel, and of damage to adjoining structures, in the event of a rocket misfiring. Moreover, 70 per cent of the Earth's surface would become a potential launching site because the rockets could be towed and set in position almost anywhere at sea.

In the Draim-Stalzer scheme, the rocket could be constructed so that it would float upright in the sea, with enough rolling and dipping stability to maintain the correct launching position. To secure the necessary stability, its centre of buoyancy is closer to the nose than the centre of gravity, and the distance between the two centres is less than four-tenths of the overall length of the vehicle. This, its designers claim, will prevent it from rolling away from its launching position as a result of the wave motion of the water, and will provide it with a good "dipping" stability as well.

The buoyancy would be obtained by constructing the rocket with a watertight jacket around its body to produce an air "jacket". The jacket would be formed by a series of metal strips riveted and sealed together. Distributed at a number of points inside the rocket would be explosive "squibs". The squibs on being exploded would break the connections of the jacket strips to rip them away from the rocket at the moment of launching. The entire rocket would be encased in a thin plastic envelope to prevent corrosion from exposure to the sea water and air.

In brief . . .

A TEST PLANT with a capacity of 10 tons a month for the manufacture of hydrofluoric acid anhydride from waste gas generated in the process of making superphosphate of lime is to be installed at the Osaka works of the Seibu Chemical Industry Company of Tokyo. The company is now producing sodium silicofluoride as a steriliser and the raw material for enamel from the waste gas, the principal component of which is silicon tetrafluoride. Hydrofluoric acid anhydride, employed as a cold catalyst and in the production of Freon, is obtained from silicon tetrafluoride by way of hydrofluoric acid solution which, according to the manufacturer, means that production costs are lower and the product is superior in quality.

* * *

TWO NEW VARIETIES of the blight-resistant Chinese chestnut—the only chestnut that can be grown in the Eastern United States where the blight disease that wiped out the USA's native chestnuts in the early 1900s has remained endemic—have recently been released to commercial nut-growers for vegetative reproduction, following their development by selection and testing at Beltesville, Maryland. Named Crane, in honour of the scientist H. L. Crane who worked for many years to provide growers with good blight-proof chestnuts, and Orrin, in memory of Orrin S. Good, in whose Pennsylvania plantation this variety originated, the new nuts are superior in keeping quality and flavour to all existing Chinese chestnuts now being grown east of the Mississippi.

EAST GERMANY
Watch on the melt

FOR USE in the study of melting processes, a "heat microscope" on an optical bench has been developed by VEB Carl Zeiss, of Jena, in collaboration with the Institute for Heat Technology and Automation, Jena-Burgau. It enables photographs of tests to be taken at intervals at furnace temperatures up to 1600°C. The instrument has been developed primarily as a means of studying and testing solid fuels, but it also allows high-temperature processes such as sintering, softening, melting and flowing to be observed with reasonable accuracy; this makes possible the study of structural changes in metals at high temperatures.

The sample to be heated and observed consists of only a few grains of the material, which are placed in a carrier and advanced into a ceramic tube containing the furnace. This furnace has a viewing window to serve the microscope. Provision is made for illuminating the specimen, and for protecting the apparatus by means of heat filters. The temperature measurements, made by a thermocouple, have proved accurate within ±15°C.

AUSTRALIA
Films of vermiculite

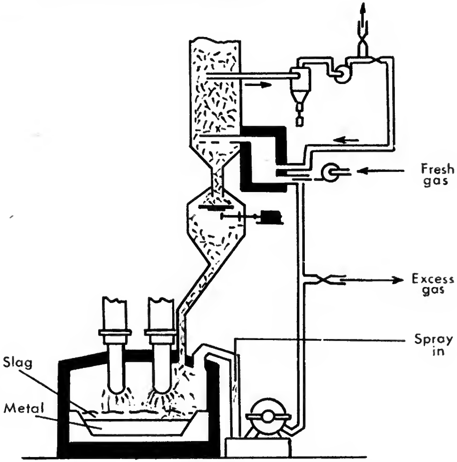
STUDIES OF the swelling in water of the naturally occurring flat, plate-like crystals of vermiculite led Dr G. F. Walker of the Commonwealth Scientific and Industrial Research Organisation's Division of Applied Mineralogy to develop a chemical method of preparing thin sheets of the mineral. Vermiculite is a micaceous mineral used as thermal insulation and in horticulture. The sheets prepared by this method have a tensile strength as great as paper and electrical insulating properties comparable to those of mica.

The sheets can be made to any thickness required, and their chemical properties can be modified by chemical treatment or by adding substances such as graphite, asbestos, or metallic powders to the vermiculite mix. Tests are in progress to determine the fire-resistance of the films when used as surface coatings and when laminated in plywood during manufacture.

In the process developed by Dr Walker, vermiculite is treated chemically and then mashed up in water. The dispersed material is dried out on a smooth, flat surface where the individual crystals of vermiculite coalesce into a continuous, flexible film.

Although details of the chemical treatment are not yet available, it is believed that the idea evolved from the observation Dr Walker made some years ago that vermiculite containing butyl ammonium ions between the crystal layers swelled to some 3000 times their original size when placed in water. The swollen crystals were homogenous and their appearance suggested that the silicate layers in the crystals remained parallel during swelling. The swelling is reversible and can be controlled by varying the concentration of butyl ammonium ions in the solution.

NORWAY Ore to steel in one plant



Sketch of the proposed steelmaking process. Each furnace electrode is served by its own open-topped shaft, and any number of electrodes may be used.

IDEAS FOR DISPENSING with the blast-furnace in the conventional iron-making cycle, by making steel directly from iron ore, are prevalent in such countries as Norway where the ore is rich in iron. The problem in Britain is to find a process that works when only poor-quality ores are available. A robust system that has an air of simplicity about it, and would seem to lend itself to continuous operation, has recently been patented by the Oslo firm of Elektrokemisk. The idea, basically, is that ore should be "pre-reduced" and then fed directly to an electric arc furnace, where it would be further refined. Because of its link with the arc furnace the process might also be suitable for the refining of oxide ores other than those of iron.

Raw ore is poured into one of several refractory-lined shafts, open at the top, along with a reducing agent such as coal or coke. The ore is reduced to metal as it descends slowly against a counter-current of hot gases, rich in carbon monoxide. This gas is obtained as a by-product of the subsequent electric refining operation and is extracted before it reaches the top of the shaft; it can be recycled if necessary, to prevent the ore over-heating and fusing into a solid mass.

When the ore has been reduced it is tapped from the base of the shafts by rotating tables (see sketch), and allowed to descend sloping shutes that lead through the roof of the electric arc furnace. The technique envisaged by the company does not involve the addition of steel scrap to the arc furnace, as is customary, though presumably this would be necessary; nor is mention made of the rather extensive refining that would have to be done in the arc furnace. One presumes the refining operation would be accomplished with the aid of oxygen injection, and one or more intermediate slag-removing operations. Facilities are proposed for washing "fume" (finely-divided iron oxide and other particles) out of the effluent gas, although it is arguable that this fume might itself be reduced along with the ore.

An intriguing aspect of the process is that, although at present conceived as semi-continuous—molten steel being tapped from time to time—it would seem to provide a basis for continuous steelmaking. But more research would be needed.

The challenge of experimental medicine

Through the development of techniques for the induction of non-infectious diseases in laboratory animals a widening range of human ills are being investigated scientifically. Causes of disease can be sought and methods for treating them perfected before they are tried in human patients

by Dr S. H. Zaidi
Head, Division of Experimental Medicine,
Central Drug Research Institute, Lucknow, India

MEDICAL research was, up to the 1930s, mainly concentrated on mastering infectious diseases. Diseases of non-infective origin, including those of the heart; cancer; occupational diseases; nutritional disorders; psychosomatic diseases, which are still a potent cause of disability and mortality — these were studied only in limited ways because they could not be experimentally investigated. The discovery of techniques for producing and studying the non-infective disease processes in laboratory animals, however, has opened a new vista of knowledge. These techniques have given many useful leads to the understanding and treatment of human disease.

Diseases of the heart and blood vessels are the most prevalent cause of death and suffering all over the world. One of them is atherosclerosis, which is characterised by extreme thickening of the vessel wall as a result of fat deposition and formation of connective tissue. Complete obstruction of the lumen of the coronary arteries is sometimes brought about suddenly by the formation of a blood clot (thrombus) leading to the death of the heart muscle (myocardial infarction). The first attempt to produce myocardial infarction in experimental animals was made by Peter Ludwig Panum, the Danish physiologist, in 1862; he injected into the aorta of dogs a mixture of oil, wax, tallow and lamp black and thereby created an artificial blockage. Various methods have since been used for the production of myocardial infarction. They include cutting off the blood supply and the use of physical agents such as heat, X-ray irradiation, and surgical interference.

In the 1920s a Russian physiologist, Anitschkow, discovered that atherosclerosis could be produced in rabbit (Figures 1, 2 and 3), rat, dog, guinea-pig, golden hamster, monkey or chick either by simple cholesterol feeding or by a modified cholesterol saturated fatty acid diet. This has provided a clue that, in the origin of atherosclerosis, dietary factors, along with a derangement of cholesterol biosynthesis, may be operating in human subjects. A number of substances have also been found to increase the tendency of blood to coagulate in the blood vessels of the living animals: cephalin, ethanolamine phosphatide and butter.

Animal experiments have proved useful in the search for suitable remedies for the control of atherosclerosis. Restriction of excessive intake of animal fats and the use of vegetable oils containing large quantities of essential unsaturated fatty acids, vitamins C and B_{12} and nicotinic acid have proved to be of value in reducing blood cholesterol and the incidence of atherosclerosis in animals. The administration of female sex hormone and the extract of the thyroid gland arrests progress of atherosclerosis in both rabbit and chick. The use of the anticoagulant, heparin, has been found to inhibit the development of atherosclerosis and prevent thrombosis. Certain synthetic compounds, such as MER-29, benzmalecene and farnesoic acid, block the natural synthesis of cholesterol in the liver and thereby help in reducing blood cholesterol. Recently, in the treatment of acute coronary thrombosis, the intravenous infusion of the enzyme fibrinolysin has gained prominence because it could break up blood clots produced artificially in the arteries of animals.

Another important disease of the blood vessels is essential hypertension. In this condition the plain muscles of the small arteries and arterioles remain in a sustained state of constriction, which produces rise of blood pressure. The increased pressure against which the heart has to function may cause enlargement and failure. The development of the disease is an insidious process and the cause is unknown. The first attempt to produce hypertension in dogs was made by Harry Goldblatt the American pathologist, who in 1934 reduced the blood flow through the kidneys by applying an adjustable silver clip on the renal artery. Experimental work, thereafter, in various species of animals revealed that multiple factors, involving the kidneys and the adrenal gland, the nervous system and electrolytes, played a significant role in the origin of essential hypertension. Recent experiments have shown that sodium ions influence muscle contraction, and the ratio of sodium inside and outside the cell (sodium gradient) is an important factor in essential hypertension. A large number of remedies have been added to the physician's armoury as a result of animal experiments: drugs causing depression of central nervous centres *(Rawolfia serpentina)*; those acting directly on the plain muscles of the arteries (pthalazine compounds); and ganglion-blocking agents which minimise the reflexes which promote high blood pressure.

The second highest cause of human mortality from disease is cancer, and here experimental medicine has a major part to play. Experimental cancer, similar to almost any known type of human cancer, can be induced in a variety of animals by the use of carcinogenic initiators which are physical, chemical or even hormonal and physiological. To give one or two isolated examples among many: lung cancer has been induced in experimental animals by the application of tar or injection of 1:2:5:6-dibenzanthracene, by urethane given in drinking water, and by inhalation of soot, smoke, exhaust gases, dust from tarred roads, and inorganic dusts such as asbestos. There is now evidence that inhalation is possibly the route of the carcinogen that produces pulmonary tumour. Cancer of the breast can be produced by carcinogenic hydrocarbons, by the transmission of

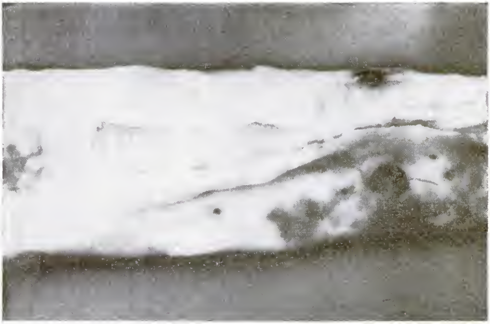
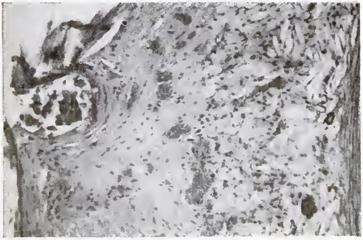


Figure 1. *Aorta of rabbit showing advanced cholesterol atherosclerosis and multiple ulcers after intermittent lipaemia produced by cholesterol feeding × 6.*

a milk agent from animals of high tumour strains, or by injections of oestrogen. Given experimental cancers in laboratory animals, it is possible to search for possible anti-cancer drugs and large series of chemical compounds are tested in this way.

In our industrial age the inhalation of certain dusts causes much morbidity and mortality. The lung condition known as pneumoconiosis can be induced experimentally by exposing animals to the inhalation of dust or by injecting the dust through the wall of the chest. Various kinds of dusts have also been studied in other tissues of laboratory animals, to observe their toxicity and the way they promote the production of fibrous tissue. Such experimental studies have, for example, shown that silica which produces tissue changes in the lung exists in four forms which have different pathogenic action although they are chemically similar. They have also shown the importance of the size of the dust particles; it appears that those below 5 microns in diameter are responsible for the production of silicosis. This information has been of value in developing dust control devices and respirators.

Another important variety of pneumoconiosis is that of coal miners. It was inexplicable before the techniques of experimental medicine were applied. Clinical and X-ray examination of South Wales miners' lungs shows that massive fibrosis —production of fibrous tissue—is often present. (Figure 4 overleaf shows early fibrosis of the myocardium of a rat.) Yet the silica content of such lungs is, more or less, the same as that of the normal lung, and it is also difficult to culture tubercle bacilli from these lungs. In 1940 two researchers at the Post-graduate Medical School at Hammersmith, T. H. Belt and B. G. Ferris, suggested a biological factor "X" supposed to be responsible for the massive fibrosis which incapacitated miners. Experimental work conducted at the Post-graduate Medical School, London, has shown that coal dust alone produces no lesions in the lung, while tubercle bacilli alone produce



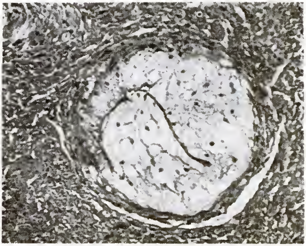


Figure 2. *(Left) Section of advanced atherosclerotic aorta of rabbit showing ulceration, vascularisation and fibrolipomatous lesions in the plaque staining Haematoxylin and Eosin × 150.* **Figure 3.** *(Right) Section of heart of rabbit showing atherosclerotic occlusion of coronary artery after cholesterol and oil feeding H & E × 150.*

The challenge of experimental medicine *continued*

lesions which regress to small nodules in a period of one year. But coal dust and tubercle bacilli *together* cause extensive tuberculous cavities in experimental animals. If the strain of tubercle bacilli is of low virulence, pulmonary massive fibrosis similar to that seen in the South Wales miners is noted. This elucidation of factor "X", supported by clinical evidence, may in course of time greatly improve industrial hygiene among miners.

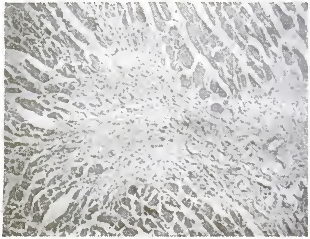
In the search for means of preventing pneumoconiosis, other than by dust suppression or respirators, the admixture of very small quantities of aluminium with quartz dust has been found to protect the lungs or rabbits from fibrosis, which the dust would otherwise cause. Provided a thin impermeable layer of alumina existed on the quartz particle it completely protected the tissues from any toxic effect. On the basis of this experimental work, first at the McIntyre Mine in Canada and then in the United States, aluminium was tried and is still under investigation as a prophylactic measure against silicosis. In recent years, a chemical approach to the treatment of pneumoconiosis has also been made. Steroid administration, mainly cortisone and ACTH, was found to be of value in treating silicosis in experimental animals. Thiosemicarbozol and related compounds, as well as insulin, thyroxin, diethyl-stilbesterol, have been used to check the development of silicotic nodules. Mepacrine, surface activator 48/80, a large series of antimalarial compounds and antiprotozoal drugs have been tested for anti-silica activity. However, extensive experimental work, as well as clinical evidence, tends to confirm that the solution of the problem is in prevention and not in the treatment of an established condition.

Another medical problem which has been the subject of much experimental work is peptic ulcer. In a survey in Britain the incidence of peptic ulcer in the age group 45-54 has proved to be 10 per cent—it was highest among doctors and executives. In spite of extensive experimental and clinical research the cause of peptic ulcer has remained obscure. The classical experiments in the production of chronic peptic ulcer in animals by surgery were conducted by F. C. Mann and C. S. Williamson of the Mayo Foundation in Minnesota in 1923, who divided the alkaline juices from the pylorus, the opening of the stomach, into the duodenum. F. H. Van Wagoner and T. P. Churchill of Northwestern University, produced chronic ulceration in dogs in 1931 by varying doses of cinchophen (see Figure 5): the earliest ulcer developed in 8 to 10 days. Recently we have observed in India that the oral administration of phenylbutazone over a period of 30 days produces chronic gastric ulceration in guinea-pigs and dogs similar to that seen in man. We have shown that phenylbutazone (or one of its metabolic products) damages the mucous barrier of the stomach; and that the corrosive action of the stomach acid possibly then keeps the ulcer in a chronic stage. These methods for the production of chronic ulcer in animals have opened up the possibility of further studies on the mechanisms of the disease in man. In view of the conflicting opinions regarding the normal causes of peptic ulcer, no satisfactory treatment has so far been evolved. Some of the relevant experimental approaches made include dietary control, antihistaminics, antacids, anticholinergic drugs and mucous stimulants. Hormone therapy, enzyme inhibitors and organ-extract therapy have also been tested.

Many of the diseases have been approached by the techniques of experimental medicine. In the field of nutrition, for example, Deo and Ramlingaswami in 1932 experimentally produced in rhesus monkeys, by the deficient administration of total protein, a liver condition similar to kwashiorkor; their finding has enabled the prevention and treatment of this condition among the African and South American population. Cirrhosis of the liver can be produced in laboratory animals by the administration of carbon tetrachloride, phosphorus, phosphorus and alcohol, tars, selenium and carcinogenic agents (butter yellow). Since Christian Eijkman (1897) produced in fowls fed on boiled rice a condition resembling human beri-beri; the enumeration of the vitamins has been largely dependent on animal experiments. Again, diabetes mellitus is a disease which, from the discovery of insulin in 1922 to the present day, has been a subject of continuing researches in experimental animals. Finally, it must be mentioned that the attempts experimentally to produce states of animal human behaviour resembling psychoses have opened up a new field of medical research, which is helping us to understand the nature of mental illness.

For all that has been and is being accomplished, experimental medicine is still in its infancy. In this brief outline, emphasis has been given to the reproduction of diseases in the laboratory animal, a technique which has always posed inherent problems. Individual differences, species differences and genetic and immunological differences greatly influence results. Today, these obstacles are being overcome by designing experiments to employ a very large number of animals. Recent studies of the biochemical and biophysical aspects of functional derangement at the cellular and sub-cellular level have further widened the frontiers of experimental medicine.

FIGURE 4. *(Below) Section of heart of rat showing evidence of necrosis and early fibrosis of the myocardium as a result of combined effect of fat feeding, dihydrotachysterol and adrenaline H & E × 150.*



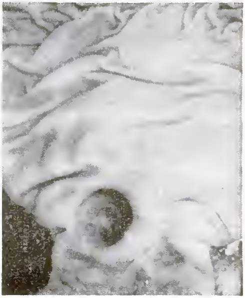
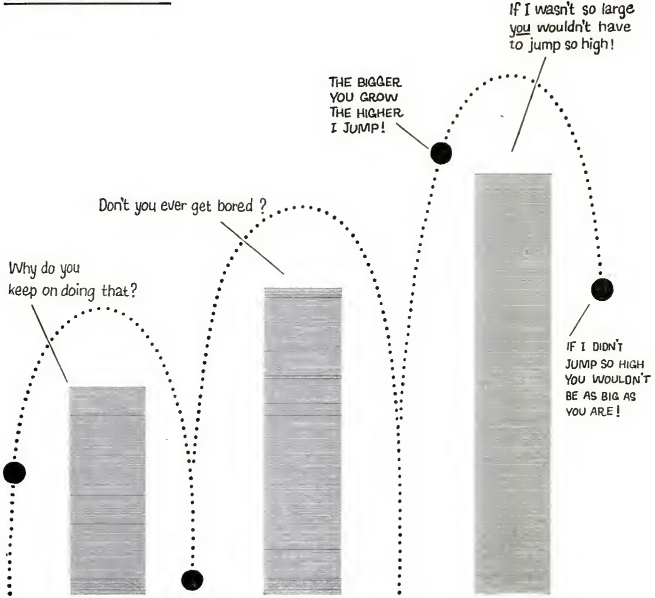


FIGURE 5. *(Right) An experimental peptic ulcer produced in dog by the oral administration of cinchophen (200 mg./kg. daily for 20 days). A solitary deep well defined punched out ulcer is noted at pyloro - duodenal junction and the adjacent gastric mucosa markedly thickened × 1.*

SUPPLY AND DEMAND


Why do you keep on doing that?
Don't you ever get bored ?
THE BIGGER YOU GROW THE HIGHER I JUMP!
If I wasn't so large you wouldn't have to jump so high!
IF I DIDN'T JUMP SO HIGH YOU WOULDN'T BE AS BIG AS YOU ARE!

How Shell-Mex and B.P. are keeping one jump ahead of demand at Leeds

Does demand create supply or supply, demand? Like the chicken and the egg, either there isn't an answer or there is and we all know it: they both depend, and react, on each other.

Hence our new extensions at Leeds. They have been prompted by the enormously increased demand for fuel oils and lubricants in the Midlands and North of England. When completed they will treble the storage capacity of the depot to 36,000 tons. They are also, among other things, making extensive use of rail transport to carry motor spirit to the new installations, which themselves cost £500,000. These are considerable figures for this type of installation. But even now it looks as though demand will rise even faster in the future. If so, we're ready for it. One jump ahead.

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Colour television for Europe

This month European broadcasting officials have been attending demonstrations in London to help them agree on a system for transmitting colour television pictures. The choice is not an easy one, because the advantages and disadvantages of the contending American, French and German systems are nicely balanced

by Ronald Brown

OCTOBER is now considered a likely time for the Western European broadcasting authorities to arrive at a definite recommendation on the choice of an agreed television transmission system for Europe. It will be a difficult choice to make for, given good conditions, there seems to be little advantage on balance between three systems that are available. The final decision can only be arrived at after very careful statistical analysis of the advantages and disadvantages of the systems and, in particular, a comparison of their behaviour under adverse conditions. During the past few weeks there has been intense colour television activity in London, centred on the private demonstrations that have been given to the Ad Hoc Colour Group of the European Broadcasting Union and to delegates from the OIET, representing eastern European countries, including the USSR.

The three colour transmission systems are the NTSC system developed in the USA (which has been in regular use for ten years), the Secam system developed by the Compagnie Française de Télévision (which has recently been considerably improved) and the PAL system announced by the Telefunken Company of Germany in February. The advocates of the PAL and Secam systems have repeatedly said that if the decision could be delayed to allow further development work the full potentialities of their systems could be realised and a better and more accurate choice could then be made. However, the BBC, among others, considers that a decision is now a matter of some urgency and can be made very quickly on the basis of a comparison of the systems as they stand and an estimate of their possible development potential.

System	*For one line of the picture*	*For the next line of the picture*	*Main feature of the system*
NTSC (American)	*Saturation (by amplitude modulation)* *Hue (by phase modulation)*	*Saturation (by amplitude modulation)* *Hue (by phase modulation)*	*Continuous transmission of full colour information*
Secam (French)	Colour value 1 *(by frequency modulation)*	Colour value 2 *(by frequency modulation)*	*Colour information combined using delay line in receiver*
PAL (German)	*Saturation (by amplitude modulation)* *Hue (by phase modulation)*	*Saturation (by amplitude modulation)* *Hue (by phase modulation, but shifted in phase)*	*Colour information checked using averaging circuit and delay line in receiver*

How the three systems transmit colour (chrominance) information

The basic requirement of a colour transmission is that the brightness and colour of each little element of the picture should be specified in a form suitable for radio broadcasting. All the three systems under discussion use similar methods. Indeed the PAL and Secam systems are really only slightly modified versions of the original NTSC system. These modifications are, however, important and were introduced in an attempt to overcome difficulties inherent in the basic NTSC system. The three systems provide "compatible" signals; that is, the transmission will produce a colour picture on a colour receiver and a black-and-white picture on a black-and-white receiver. Compatibility has long been regarded as an essential requirement for practical colour broadcasting.

To achieve it, two transmissions are used. The first of these, the *luminance* transmission, employs methods essentially the same as those of the black-and-white television system and produces a picture on a black-and-white receiver. The second transmission, the *chrominance* transmission, has virtually no effect on black-and-white receivers but, when combined with the luminance transmission in a colour receiver, it produces a picture in full colour.

This procedure is made possible by the fact that any coloured light can be specified by three quantities defining its luminance (brightness or brilliance), its hue (the blueness, redness, etc., of the light), and its saturation (the "pale" or "deep" quality of the colour). The hue and saturation information, carried out by the chrominance transmission, is represented geographically in Figure 1.

In all three systems the hue and saturation values are transmitted by impressing them on a "sub-carrier" wave which, in turn, modulates the main vision carrier wave carrying the luminance transmission. In the NTSC system, for example, the sub-carrier has an accurately determined frequency of 3.579545 Mc/s and it is, in effect, fitted into gaps in the luminance information. Where the systems differ is in the methods employed to impress these two distinct pieces of information, the hue and the saturation, on to the sub-carrier.

Development by the National Television System Committee in the United States, the NTSC system is widely used in North America, Japan and Brazil. It will certainly become the standard for colour broadcasts for North and South America and Japan and probably for Australasia and the South-western Pacific area as well. In this system, the amplitude of the sub-carrier wave is a measure of the saturation of the colour, while a change in the hue causes a shift in the timing (a phase shift) of the sub-carrier. Thus, as the different saturations and hues in successive elements of the picture are scanned, the amplitude and phase of the chrominance signal changes accordingly. Because the sub-carrier carries the two pieces of information simultaneously, the relationship between the two must be maintained very accurately throughout the system. For example, co-axial and microwave links carrying the signal over distribution networks must be very accurately adjusted and maintained—by no means an easy thing to do. Tape-recording of colour was initially very tricky because slight mechanical variations in the movement of the recording and pick-up heads caused phase changes in the sub-carrier and thus changed the hue of the picture. In the receiver, a synchronous detector that is rather expensive and difficult to adjust is needed to recover the information from the sub-carrier.

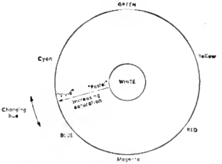
It was in an effort to resolve some of these difficulties that CFT developed the Secam system. The name is a combination of the words "sequential" and "memory" and it is in the sequential transmission of the colour information and the addition of a memory device to the receiver that the Secam system chiefly differs from the NTSC system.

Hue and saturation values are not impressed directly on the chrominance subcarrier in this system. Instead, two values derived from the hue and saturation values are used. This is not, however, the main point. What is important is that, instead of transmitting these two signals simultaneously, they are transmitted one after the other. As the camera scans one line of the picture one of the two colour values is transmitted. As the camera scans the next line an electronic switch operates and the other colour value is transmitted. In the receiver, the first colour value is stored in a "memory" device until the next line scan begins and is then combined with the other colour value as it is received. The memory device is nothing more than a "delay line" through which the signal travels, taking a time exactly equal to the duration of one picture line (about 60 microseconds).

In the receiver the luminance signal is connected directly through the matrix. A bandpass filter separates out the chrominence signal and it is connected through to the electronic switch directly and also via the electrical delay line.

Plainly, as two line scans in the Secam system are required to give the necessary colour information, the colour definition of the Secam system is only half that of the NTSC system. This does not appear to matter, however, because the human eye is very insensitive to colour detail—much less sensitive than it is to black-and-white (luminance) detail. And, because the two colour values are transmitted separately, satisfactory colour rendering is possible in the presence of much larger errors in transmission than is possible with the NTSC system. Even more "robustness" is added to Secam by impressing the colour information on the sub-carrier by varying its frequency instead of its phase and amplitude, as in the NTSC system. These properties of the system are of particular importance when the pictures have to be transmitted over the networks or recorded on magnetic tape.

Moreover, the synchronous detector of the NTSC receiver is replaced by a much simpler frequency modulation discriminator in the Secam system. Also, there is no hue control knob fitted to the Secam receiver, and experience in the United States, where most colour receivers require hue control, indicates that its absence would make life a good deal easier for the ordinary viewer.



Specification of colour (chrominance) by hue and saturation.

Great though these advantages of Secam may seem to be, it does look as though it will be more susceptible to interference, particularly in fringe areas. The delay line may also prove to be rather expensive. If put into production for a market measured in millions it might not cost very much; but production may for some years be counted in thousands rather than millions.

An attempt to combine the best of both the NTSC and the Secam systems has been made by the Telefunken Company in their PAL system. As in the NTSC system the hue and saturation values are transmitted simultaneously by impressing them on to the sub-carrier, hue changes causing phase changes in the sub-carrier and saturation changes causing amplitude changes. The phase of the chrominance signal is, however, deliberately shifted by part of a wavelength ("reversed") between line scans, hence the name, "Phase Alternation Line". The phase is reversed back again in the receiver and, by averaging the chrominance signals on successive lines, possibly with the help of a Secam-type delay line, any errors can be averaged out. For comparison, phase errors arising in transmission of as much as 30° or 40° produce no deterioration of the picture in the PAL system, whereas the NTSC system can tolerate errors of not more than about 5°. As with the Secam system, no hue control is fitted but, again, a possibly expensive delay line is necessary. Although a receiver can be used without a delay line it gives poorer results.

Opinion in the BBC seems to place the interest of the viewer first. It is said that all the defects on the transmission and recordside of the NTSC system can be overcome —at a price. This price is small compared with the total cost of the receivers and the BBC would not hesitate to spend it if the chosen system produced the best results for the viewer. The ideal system from this point of view would be the one that provided a good quality, interference-free picture, particularly in the fringe areas. The adjustment to the receiver would be simple and servicing easily carried out.

The networking of the NTSC system in Britain would not seem to present any great problems, because the co-axial lines and microwave links which will be made available by the Post Office will be well up to NTSC requirements; the Post Office will want to use the same lines to carry many hundreds of telephone conversations at other times, and this calls for very stringent phase and amplitude control.

Great importance is, however, placed upon agreement between the different Western European nations and between them and the Eastern European nations. The Russians are known to be interested in Secam and PAL because of their extremely long distribution lines.

A compromise that has been suggested would use PAL for transmission over the distribution networks and NTSC for broadcasting to the home viewer. It is certainly easy to change from the PAL to the NTSC system as and when required. It is interesting to note that the amount of time devoted to PAL transmissions by the BBC during the week of the main demonstrations was considerably more than had been given in their published programme—perhaps an indication of unexpected interest by the delegates.

The supporters of NTSC may be confident of their ability to adjust transmission lines accurately, even if it means going to some expense, but the errors produced on long transmissions are cumulative. It would be interesting to see the result on a domestic receiver in Western Scotland of a picture transmitted by the NTSC system from a tractor farm in the Urals through seven or eight different countries!

The complicated mesh of advantages and disadvantages of the three systems will have to be very carefully unravelled in the months ahead. The balance is probably so fine that the decision will be made on the basis of which disadvantages can best be disregarded. Political pressures, and the influence of some of the larger manufacturers who are known to prefer to make a single world-wide standard of the NTSC system may also play their part. The director of engineering of the BBC has said that, if a decision were made in favour of the NTSC system, a service could be started in England early in 1965.

There remain the other technical problems, however, in the colour cameras and in the domestic colour display device, which still leave much to be desired in simplicity and cheapness. Nevertheless, the advent of colour in British broadcasting cannot now be far off, and an early agreement among the European broadcasters on the choice of the transmission system, and confirmation by the International Radio Consultative Committee, will help to bring it nearer.

Trends and Discoveries

Comparing mean sea level in Britain and France

RECENT EFFORTS to achieve a United European Levelling Network have focused attention on the fact that it is difficult to equate the datum levels of the British and French levelling networks to any great degree of accuracy. The two systems are based on mean sea level at Newlyn and Marseilles respectively, but there is insufficient data on temperature, salinity, currents, wind, etc., to effect a correlation. However, if the slope of the sea surface across the Channel is considered, changes in salinity are unimportant, and although currents are strong, these and other variables are kept under regular observation.

Two other methods exist for relating the two levels. The first is by optical sighting but, because of atmospheric refraction, the best accuracy that could be achieved would be about half a metre. The other alternative would be to lay a pipeline filled with water across the Channel and observe the surface levels at each end. This would be expensive and previous experience has shown that trapped air can cause difficulties.

The most recent correlation has been made by D. E. Cartwright and J. Crease, of the National Institute of Oceanography (*Proceedings of the Royal Society*, Series A, Vol. 273, p. 558). They analysed the differences in mean sea level between Ramsgate and Dunkerque on the basis of a 723-day period of tidal and other data recorded during 1957 and 1958. The two stations were chosen because they both have reliable tide gauge records.

The major kinematic effect causing the sea's surface to slope is that due to the tidal currents. They can produce a slope of some 50 cm per 50 km. Fortunately a continuous record is kept of the voltage generated in a cross-channel telegraphic cable by movement of water in the Earth's magnetic field, and the two oceanographers used this to determine the total flux of water. The next most important correction was for wind which at times can produce a slope of 10 cm to 50 km; and finally for air pressure which produced up to 4 cm difference over 50 km.

The Ordnance Survey re-estimated the levelling data for the Ramsgate gauge, and the Service Hydrographique de la Marine supplied the relevant figures relating the Dunkerque gauge to the "Nivellément General". It is an interesting sidelight that the Dunkerque gauge is described as a modern high-precision instrument installed in 1956 and that the Ramsgate gauge was installed in 1843 and "has always worked well". The investigation showed that the Ordnance Datum during 1957-58 was 19.6 cm below Zero Officiel du Nivellement General de la France, with a standard error of ±1.5 cm.

Pine needles record fallout

AS A RESULT OF nuclear weapons tests many countries have started routine fallout survey programmes. The selection of material suitable for observation is very important and R. Szepke of the Central Laboratory for Radiological Protection, Warsaw, has just published the results of a survey of wild plants that are available throughout the whole year for monitoring fallout. Long-growing plants such as moss, lungwort, heath and the needles from pine trees were found to have the highest radioactivity. Since pine forests cover 17 per cent of the area of Poland and pines are prevalent in other northern countries, the activity of pine needles (*Pinus silvestris*) was studied over the period 1959-61 and compared with the results from two nearby fallout sampling stations (*Atompraxis*, Vol. 9, p. 218).

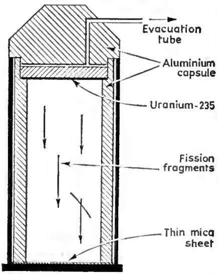
Szepke found a very good correlation between fallout rate and gross activity of the pine-needle ash. The sharp decrease in fallout in 1959 followed by a slight rise in spring 1960 showed up clearly. He also noted that during high fallout periods the activity of two-year-old needles was about three times greater than that of one-year-old needles—during the "atomic calm" of 1960-61 there was no difference. From further tests he concluded that of the materials examined, young pine needles were the most homogeneous and, because of their widespread growth, can be recommended as a good bio-indicator of radioactive contamination.

Italian—US satellite

ROCKET TESTS for the first joint Italian-US San Marco satellite are currently under way in America. A Scout rocket will launch the satellite from a "Texas Tower" in the Indian Ocean probably some time in 1964. To fulfil its main aim—the measurement of variations in atmospheric density by the aerodynamic drag on the satellite—the Italian scientific team at the Aerospace Research Centre, Rome, headed by Professor L. Broglio, have designed a "drag balance".

It consists of a light outer structure enclosing a heavier concentric one to which it is coupled by non-rigid connections. The outer shell is very sensitive to changes in the drag force while the inner one tends to continue its normal orbital trajectory. Forces are set up in the non-rigid links that can be changed into electrical signals and telemetred back to Earth.

Molecular sieves made by irradiation



A NEW METHOD of forming fine holes of near atomic dimensions in thin mica films, glass, silicates and similar materials has recently been described by R. L. Fleischer, P. B. Price and R. M. Walker of the General Electric Research Laboratory, Schenectady, New York (*Review of Scientific Instruments*, Vol. 34, p. 510).

The method is based on chemical etching of the path of radiation damage produced by the passage of a heavy charged particle as it traverses a solid. A collimated beam of particles is produced by mounting the mica sheet at one end of an evacuated aluminium capsule, and, at the other, a disc of aluminium on to which has been deposited a thin film of uranium about five microns thick—much less than the range of fission fragments, so that the fragments leave the uranium with little loss of their orginal fission energy. The capsule is irradiated in a reactor and fission fragments are produced from the thermal neutron capture of uranium-235. About 95 per cent of the tracks produced are around seven microns long, the maximum length approaching 12 microns.

A few seconds etching in 20 per cent hydrofluoric acid produces channel widths of about 25 Angstrom units and larger sizes can be produced with longer etching times. For a given arrangement the hole density is dependent on the total dose. The maximum practical density is about 10^{11} holes per sq. cm. Above this samples become very brittle and excessively radioactive.

For low hole densities a synthetic mica or freshly prepared glass film must be used as most natural micas contain background tracks arising from spontaneous fission of uranium impurities. It has been verified from electron micrographs of thin films taken from a 12 micron thick mica sample that the holes have a constant diameter though their shapes may be controlled by the crystal lattice. Thus very even molecular sieves can be made. If a heavy particle accelerator were used, holes considerably longer than 12 microns could be produced.

A new way to find the brain's blood flow

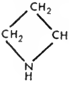
THE RATE OF FLOW of blood through the brain can be measured by one of several methods involving physical sampling of blood at various points. All of these methods are extremely complex and involve extensive calculation to obtain an answer. None is suitable for clinical application since abnormal brain function which affects blood flow can occur simply due to the adverse psychological effects of the test situation. Several workers have studied the passage through the brain of isotopes after injection into one of the carotid arteries feeding the brain but, although more rapid answers can be obtained, the same objections apply.

A new radio-tracer method has now been developed by W. H. Oldendorf of the Los Angeles Veterans' Administration Center (*Nucleonics*, Vol. 21, No. 4, p. 87). The system uses a gamma-emitting isotope which is injected into a vein in the arm. An iodine-131 labelled salt of hippuric acid is used—it is cheap, costing only a few shillings for each test and is rapidly excreted.

Although simple the method suffers from the drawback that the slug of tracer first has to pass through the heart and lungs; thus only a percentage reaches the brain and its arrival is spread out over several seconds rather than arriving as a single slug. However, by making a continuous record of the brain's radioactivity the transit time can be determined (7-10 seconds in a normal adult). With the transit time and knowing the brain's blood volume, the flow-rate can be easily calculated.

To determine this volume a 10 microcurie dose of iodine-131 serum albumin is injected and the amount in the brain after a few minutes is measured using collimated radioactivity detectors. From the total body blood volume the brain blood volume can then be found. The new technique should prove useful in the investigation of vascular diseases.

Lilies supply an amino acid analogue



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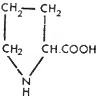

2.

A COMPOUND that is characteristic of the lily family is L-azetidine-2-carboxylic acid (1). It is found in especially high concentration in lilies-of-the-valley. Chemically it is the lower homologue of proline (2), an important constituent of proteins. Previous research work has failed to find an effective proline analogue but recently L. Fowden and M. H. Richmond of University College, London, and the National Institute for Medical Research, Mill Hill, have shown that azetidine-2-carboxylic acid does in fact take the place of proline in at least two organisms (*Biochimica et Biophysica Acta*, Vol. 71, p. 459).

If the compound is added to a growing culture of the bacteria *Escherichia coli* its growth is immediately inhibited. The effect can be reversed by adding the same concentration of proline to the growth medium. The protein resulting from the inhibited cells of the bacterium contains 30 per cent less proline than that from normal cells, the difference being made up by the analogue.

Growth inhibition also occurs when azetidine-2-carboxylic acid is supplied to mung bean seedlings when nearly all of the proline is replaced in the newly synthesised protein.

The inhibitory effect of the analogue is probably due to the synthesis of proteins with altered molecular shapes. Neither proline nor its analogue fit into the typical, so-called alpha-helical structure of the protein molecular chain, but they cause the axis of the helix to bend. Azetidine-2-carboxylic acid turns the helix through an angle 15° smaller than does proline. This could lead to the synthesis of enzymes and other important proteins with reduced biological activity and, ultimately, to growth inhibition of the organism. The discovery is likely to be very useful in biochemical research.

Some topics discussed at a symposium on "Foraging and feeding behaviour" held by the Association for the Study of Animal Behaviour, at the Zoological Society of London, Regent's Park, 9-11 July.

Monkeys and new foods

TWO RESEARCHERS, L. Weiskrantz and A. Cowey, of Cambridge University Psychological Laboratory, described their work on the response of rhesus monkeys to new foods. The amount of a new food the monkeys consume when it is regularly offered may be quite small on the first few days, even though they sample it promptly, but may increase after several weeks. One important factor in determining whether monkeys accept a food is the experience of seeing another monkey eat it. By arranging this, a "non-consumer" can be converted to a "consumer".

The best use of bees in orchards

OBSERVATIONS by J. B. Free, of Rothamsted Experimental Station, have established that honey-bees collecting pollen from fruit-tree flowers are more likely to pollinate other flowers than nectar-gatherers, since these, especially on some varieties of apple, do not touch the clusters of pollen sacs inside. Most bees concentrate on either pollen or nectar, and the proportion collecting pollen, which normally varies from day to day, and also throughout the day, can be increased by feeding the bee colonies with sugar syrup.

Bees rarely visit more than two trees on a foraging trip, and these are usually in the same row. In tree varieties needing cross-pollination the proportion of fruit which is "set" is thus lower on trees further from the "polliniser" type of bee colony, and sometimes even on the sides of individual trees furthest from the polliniser. Thus colonies of bees for orchard pollination should be arranged in several small groups. They should not be moved to the orchard before flowering has begun, or else the bees may become used to visiting other species of flower, and then be reluctant to change.

Baiting rabbits

RESEARCH BY A. J. B. Rudge, of the Ministry of Agriculture's Infestation Control Laboratory, Guildford, has shown that British wild rabbits can be attracted to, and will eat, bait—unpoisoned in the experiments. The baits must be placed so that the rabbits can see the next baiting point from any given one. Two yards, Dr Rudge has found, is a suitable interval.

Whole carrots were the rabbits' preference out of six baits tried, and they would eat these even when there was plenty of alternative food available. Young rabbits caught over forty yards from the bait had not eaten any, but adults with carrot in their stomachs were found up to 400 yards away from the nearest bait. The results suggest that baiting may prove a feasible way of controlling rabbits.

What makes the stable fly start probing?

THE STABLE FLY, *Stomoxys calcitrans*, shows a probing response—a vigorous thrusting movement of the extended proboscis—in response to certain odours as a preliminary to feeding. Its behaviour has been studied by Miss B. Hopkins, of Imperial College, London. The vapour over an ammonia solution (0.16 per cent) produced a response in a majority of flies. More of them probed, and for longer, if the strength of the ammonia solution was doubled, but if it was halved (0.08 per cent) the effect was no greater than over water vapour. There is thus a threshold below which the flies cannot "detect" smells. The vapour over dilute *n*-propylamine and concentrated valeric, *n*-caproic and *n*-caprylic acids was as effective as ammonia.

The threshold of the probing response rose after the flies had fed on blood or a concentrated solution of sucrose. Removal of their antennae and maxillary palps (parts of the mouth) did not affect the insects' response to the ammonia vapour, but covering the lower segments of their legs with lacquer reduced it.

Advertisers' Announcement

Do you agree . . . ?

> *If we go on indefinitely experimenting with nuclear weapons, manufacturing them and stockpiling them, boasting of their potentialities, and keeping at instant readiness, sooner or later a situation will arise, sometime, somewhere, where one will go off.*
>
> Lord Hailsham, Minister for Science, August 1960

> *Food production must be increased and must be within the reach of the world's population. . . . This means a degree of co-operation between nations far greater than now exists, together with a common will among nations not to spend vast sums on armaments and weapons of destruction but to spend the money in developing the earth's resources and training the skill for that development.*
>
> Archbishop of Canterbury, March 1963

WE agree with these statements. We realize that a general war involving nuclear weapons would inevitably result in deaths and injuries both among the populations of the combatant nations and their neighbours on a scale so far exceeding anything ever experienced as to surpass most men's imagination. The aftermath would leave the survivors physically and morally devastated, and the world poisoned with radioactivity, the long-term consequences of which cannot at present be foretold with confidence.

We do not believe that war can be permanently prevented by preparations for war; such preparations tend rather to make acceptable the idea that war is inevitable. More than once recently the world has seemed to be on the brink of nuclear war. Such crises are likely to recur and to become more dangerous as nations become accustomed to the idea of using nuclear weapons. We believe that any war between powers, with nuclear weapons, will inevitably escalate into general nuclear war.

We contend therefore that the risk of nuclear war should not be run. This risk will disappear only when all stocks of nuclear weapons have been eliminated by international agreement. Meanwhile national military policies should aim at the maintenance of international stability rather than the gaining of national advantage. As steps in this direction we urge the speedy conclusion of a ban on all tests of nuclear weapons detectable by existing means, followed by the reduction of stocks to the level of small insurance forces held for the time being by the USA and the USSR. This would be consistent with the opinion expressed by Mr Robert McNamara that small independent national deterrents are dangerous.

We appeal to our own and other governments, and to the scientists and engineers who work on their behalf, to divert their energies from preparations for war to the exploration and exploitation of the world's resources to meet the problems of peace.

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LETTERS

Recession of the galaxies

Sir,—Mr Head (*Letters*, 23 May) and Mr Holman and Mr Patterson (*Letters*, 27 June) discuss one of the most basic problems which faces theoretical physics today. True, the far-reaching implications are not immediately evident from the deceptively simple question with which the problem is introduced: "Does the average distance between existing galaxies increase?" Here the word "existing" is necessary to meet the assertion of supporters of the steady state theory that new galaxies originate between existing ones. According to this theory, the average distance between all galaxies old and new, does not vary with time.

The disturbing nature of the question appears only when one pursues the implications of either of the two possible answers. Both of them are found then to challenge the way we think today about the nature of the physical world.

The answer "yes" is supported by two cogent facts. Firstly, it has been shown by theoretical physicists that a relativistic universe must either expand or contract, that, in other words, the average distance between existing galaxies cannot remain constant. Secondly, this theoretical prediction was later confirmed by observation of the red shift, of which the simplest interpretation is that the average distance between existing galaxies increases. Admittedly, serious objections can be raised against this apparently obvious conclusion:

1. If the galaxies are in relative motion, such that their average distances increase, they must have been bunched together at a finite time in the past. This postulates a particular period of time and a particular region in space from when and from where the separation began. It implies an unrepeated and unrepeatable process in the physicist's world. But the notions of a privileged moment of time and a privileged point in space, as also that processes are unrepeatable, is foreign to contemporary thinking, though it would have appeared quite acceptable in the middle ages. To return to such notions is to revise one's way of thinking about the physical world.
2. If the galaxies have velocities relative to each other, and to a starting point, they can also each have a quantity of kinetic energy that varies with their position and is infinite relative to us for a galaxy receding from us with the velocity of light. To interpret the red shift as evidence of relative motion imposes the need to explain not only how these energies were acquired, but also how it came about that the kinetic energy in unit mass can be so precisely a direct function of the distance of a galaxy from its starting region.
3. No one has been able to attribute the motion of the galaxies to anything but an initial propelling force. Why, one must then ask, has each galaxy, after it was forcibly propelled, retained sufficient cohesion to persist in its characteristic structure? One must remember that a galaxy is not a single solid object that would retain its shape if hit in one place. It is a flimsy affair; each component would have to have been hit with a force proportionate to its mass.
4. Observation shows that the apparent velocity is proportional to distance. The greater the distance between two galaxies, the greater the rate of increase in distance. No one has succeeded in reconciling this quantitative fact with any theory of an initial propelling force.

So we have a paradox: strong evidence that the average distance between exising galaxies increases and cogent reasons against the notion that this increase is associated with relative movement. Hence something in our ways of thinking needs to be revised. This is what makes the question disturbing, basic, and of far-reaching significance.

I venture to suggest that the challenge here is to the way we usually think about space. This word is applied today to two different concepts, and when the same word means different things there is always trouble. The two concepts could be called, respectively, conceptual space and physical space. Conceptual space plays no part in the physicist's world; it is undifferentiated; it has no physical properties; it is not a subject for measurement or for quantitative statements of any kind; it is meaningless to say that it expends or contracts, that it has a geometry, that it is curved or flat. One may perhaps think of it as a container of the physical world; but it is not a constituent of this world.

When relativists speak of space, they do not mean this. They refer to something of which the geometry can vary from place to place, can be measured and expressed in quantitative terms; of something that can be curved or flat; of something that is differentiated; not of a container, but of a constituent of the physical world. This is expressed by saying that space has physical properties. When one defines the distance between two bodies, one makes a statement about a physical measurement; such a statement applies to physical, relativistic space. This is why some think it would have been better if the word ether had been used by Einstein instead of space. But both words are misleading.

While it is meaningless to speak of the expansion of a non-physical quantity, such as conceptual space, it is at least not meaningless to speak of the origin, or expansion, of a space that has physical reality. It is only difficult to understand it, to represent it to one's imagination; it is just as difficult indeed as are notions of curved space, of space-time, of the origin of the matter. Thus the apparently simple question presented by the red shift challenges our basic notions about many things.

There are good reasons why one cannot separate the notion of the origin of matter from that of the origin of space, and this holds both for the evolutionary and the steady state theory. If one accepts the view that both matter and space originate continuously and in every part of the universe at a uniform rate, one is led to the conclusion that the amount of space originating between two given bodies is proportional to the distance separating them. As what originates is something with physical properties, its increase can be observed by physical measurement.

One such measurement is the wavelength of the light received from a distant source. A photon would be stretched as it travelled through expanding space; its wavelength would be greater on arrival than on departure from the source and would be a measure of the rate at which the intervening space was expanding. So relative motions of the galaxies is not the only inference to be drawn from the red shift. If one takes the expression "expanding space" literally one arrives at the strange conclusion that the distance increases between two bodies that are not in relative motion. The choice seems to be between the drastic revision of our way of thinking about space that this conclusion involves and the serious objections listed above to the inference that there is a relative motion that is proportional to distance.

REGINALD O. KAPP.

51 Stanhope Road,
Croydon,
Surrey.

Why a loaded wire cuts no ice

Sir,—I was very interested to read the précis with the above title in *Trends and Discoveries* (18 April) in which the writer stated that it is surprising that very little experimental work has been done on this subject. May I be allowed to mention that I once made some experiments on the same subject with the object of examining a mathematical formula for the phenomenon.

The underlying assumption is that the loaded wire is surrounded by a very thin sheet of water which separates it from the ice. In the contact surface between the water and the ice there exists a temperature corresponding to the pressure which it undergoes. Since the pressure is less in the upper side of the wire than in the lower, the temperature must be a little higher in the upper than in the lower, as the melting point of the ice is decreased by the increase of the pressure. Thus heat conduction occurs downwards through the wire, with the effect that the ice under the wire melts and the water above it freezes, giving off the latent heat of melting. The difference of temperature referred to above remains thus unaltered.

The mathematical analysis gives approximately the time of fall of the wire through the ice block t as

$$t = 9.06 \times 10^5 \, \frac{lab}{kw} \left\{ \frac{1}{\dfrac{1}{\frac{k}{h} + a} + \dfrac{1}{5\left(\frac{3k}{h} + a\right)}} \right\}$$

COMPANY MEETING

The Metal Box Company Limited

EXTRACTS FROM THE
REVIEW BY THE CHAIRMAN
SIR HAROLD ROXBEE COX

The company's income from sales and investments was £108,601,000, which is £9,739,000 more than last year. To this increase, the largest in the company's history, the home operations contributed £7,720,000 and the overseas operations £2,019,000.

The trading profit increased by £370,000 to £9,044,000. There was an increase at home of £450,000, but overseas profits fell by £80,000. The overseas company was faced with some particularly difficult conditions and when these are taken into account its overall performance is seen to have been good.

Whilst the increased trading profit does not represent an improvement in profit margin—on the contrary—I nevertheless regard it as a good performance against the general background of the year. The increase in taxation, however, is disproportionately high, largely because of the exceptionally severe measures introduced by the Indian budget. The profit after taxation in consequence is, at £4,932,000, only £54,000 more than last year.

However, after deducting the dividends paid to minority shareholders and the profits retained by subsidiary companies, the net income of the company is £3,867,000, which is £221,000 more than last year. This improvement has enabled the directors to propose an increase of ½% in the final dividend to 7½%, making a total of 12½% for the year. This corresponds to distributing the same proportion of the profit as last year. At the same time, in recognition of the continuing growth of your company, it is recommended that a scrip issue be made of one new ordinary share for every ten pounds of stock held.

Expenditure on fixed assets, which, in anticipation of heavy increasing demands, was exceptionally high in the year 1961-62, this year amounted to £6,845,000, of which £1,996,000 was spent overseas.

RESEARCH AND DEVELOPMENT

I have in the past year taken advantage of opportunities afforded me on public platforms to emphasize the essential connection between economic progress and technological advance. This connection is never lost sight of in the direction of our company. Our manufacturing operations are of course already highly automated, and we improve them in two ways—always by the steady development of existing methods, and sometimes by revolutionary change, for which we are constantly on the watch and which from time to time gives us a welcome increment in manufacturing efficiency. In the past year, too, we have achieved by organizational changes still closer integration of our research and development work, with attendant economy in effort.

THE OUTLOOK

At home the year has started well and I have no reason to suppose it will not continue to do so. Whilst the overseas picture is misted here and there with uncertainty I believe that the performance of the overseas company as a whole in 1963-64 will also be good.

The European Common Market has receded into the middle distance but our policy of association with European companies is unaffected and will be developed further as opportunities offer.

At the Annual General Meeting the resolutions adopting the Report and Accounts were approved, together with resolutions increasing the share capital of the Company and capitalising premiums on shares.

Letters *continued*

where k, a and l are, respectively, conductivity, radius and length of the wire, w weight of the suspended load, b thickness of the ice block, h external conductivity. The experiments performed by varying kinds of metal, length and radius of the wire and weight of the suspended load confirmed correctness of the above equation.

S. SUZUKI.

Meteorological College,
Kashiwa-city.
Chiba Prefecture,
Japan.

London's neglected technology museum

Sir,—In the "Science Museum", the exhibits seem to fall naturally into two classes: those where science predominates over technology, and vice versa.

On my last visit there I removed—in imagination—all the exhibits where technology dominated over science, and I found that there was very little left. There were Foucault's Pendulum, models of crystalline and atomic structure, early experimental apparatus, such as air pumps, Leyden jars, Atwood's machine, Magdeburg Hemispheres, early astronomical and surveying instruments, and some of the exhibits in the children's gallery, but hardly enough to fill one of the larger galleries.

There was practically nothing of what it is that causes it to be the best attended museum in the country. Many of the outstanding exhibits, especially the older ones, such as Newcomen's pumping engines, Stephenson's and other early locomotives, the textile and printing machinery and the machine tools, or the wind and water mills, represented by models, owe little or nothing to science.

As we move forward in time among the exhibits, the domination of the execution over the principle, the technology over the science, seems, if anything, to increase. There is no doubt that it is a museum of technology, with a strong bias towards engineering. As far as my sixty years of recollection of it goes it has always been so.

How has it come to be misnamed?

HUGH CLAUSEN.

17 Harman Drive,
London, NW2.

What's in a name?

Sir,—Your note on Dr D. Sheppard's research into the association of Christian names with different personal characteristics (*The importance of being John*. 20 June) surprisingly ignores the fact that as names wax and wane in popularity—whatever the reasons for this—they are frequently associated with the characteristics not only of physical age but of typical mental outlook of those who were christened when the name was particularly popular.

P. A. MARSHALL.

Flat 2,
126 Randolph Avenue,
Maida Vale.
London, W1.

Change of name

Sir,—Our technique for the high resolution autoradiography of chemically reactive surfaces was described in *Science in British Industry* (6 June). The replicating emulsion which we have developed had been referred to, for some time, in this laboratory as "H-film". We adopted that name unaware that the same name had also been adopted for high temperature resistant plastic described in *Science in Overseas Industry* (20 June).

To avoid confusion, we have changed the name of our autoradiographic emulsion to "R-film", a special feature of our film being that it retains a replica of the metal surface, which is used to locate accurately the distribution of radioactivity in relation to the microstructure of the surface.

G. T. ROGERS.
J. D. H. HUGHES.

UKAEA,
Wantage,
Berkshire.

Rule of thumb

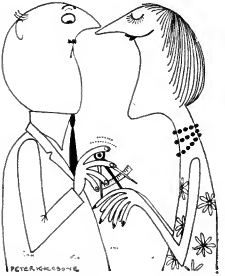
Sir,—Coming back to the question of perfect proportion (see *Letters*, 2 May—your periodical reaches us rather slowly here) surely your diagram of the perfect woman missed a point.

According to the Renaissance masters, for the perfect man or woman, the navel divides the body in Golden Section, the groin merely being the centre point of the height. At the same time, the two phalanges of the thumb are in the ratio of this section.

Perhaps some enterprising firm will bring out a small, unobtrusive, device—a sort of automatic Golden Section rule, whereby the thumbs of suitable husband or wife material might be checked before committing oneself.

M. E. DUNN.

1202 Trok Chan,
Bangkok.



Books

The right architecture for the climate

by Tudor G. Ingersoll

Design with Climate, Bioclimatic Approach to Architectural Regionalism. By Victor Olgyay.

Oxford University Press/Princeton University Press, 200 pp., 120s./$15.

THE carefully chosen title of this book contains two abbreviated architectural *manifesti*. The author has long been associated with that minority of the profession which advocates the logic of building in tune with nature, a group of architects almost completely overshadowed in the US by the technological capacity of an air conditioning industry which can rightly claim to having gotten many an architect off the hook of his own fly-in-the-face-of-climate design.

This search for environmental balance or harmony is coupled with a desire to see distinct architectural solutions produced for the world's differing geographic, climatic and cultural situations, i.e. architectural regionalism.

Those who were attracted to the Olgyay brothers' earlier work on *Solar Control and Sun Shading Devices* primarily as a new source of ideas for architectural skin treatment will find little opportunity here for easy borrowing. Readers more sympathetic to the real purpose of the book will appreciate it for what it seeks to be, a straightforward, objective analysis of the range of climatic conditions within which human habitation varies between endurable and enjoyable.

The author begins with a global survey of man's shelter patterns, noting similarities of form produced by regions of similar climate. Here the reader senses Olgyay's respect for the climatically suitable solution, whether Honan cave, New Mexican pueblo or African compass-termite nest.

Chapters II to VI draw upon all the well-known, scattered publications on climatology and micro-climatology, radiant heat transfer, and human comfort; in uniting and relating hitherto disorganised material Olgyay has done invaluable service. The section on building shape and orientation is of particular interest.

Chapter VII is borrowed in completely revised form from *Solar Control and Sun Shading Devices*. Architects who have designed and built sunshading devices will agree that in providing shade one all too frequently achieves gloom. It is therefore the more regrettable that, in adapting the earlier work, Olgyay has needlessly perpetuated the omission of any mention of existing established daylighting principles.

Chapter VIII discusses the morphology of plants and human settlements, illustrating typical suitable forms arrived at in nature through trial and error. Olgyay then outlines a method whereby it is possible to design the climatically optimum shape of a building or settlement for a given topography and climate. Much of the material for this chapter is derived from the author's own studies in the Princeton University Architectural Laboratory.

Chapter IX reviews and relates experiments on air flow patterns within and around buildings and across specific local topographical conditions. In a similar manner Chapter X organises existing information on heat flow and time lag.

In the final two chapters Olgyay lists his objectively determined criteria for the design of climatically optimum houses and settlements for four different regions of the US, directing his attention upon every aspect from site selection and orientation through house type, shape and colour, down to the design of the individual building elements. This analysis is applied to identical hypothetical sites in the four regions.

While the reader may disagree with Olgyay's design solutions on visual terms, one fact becomes apparent from the exercise, namely that no positive harm and much good can come of architects' increased use of this design approach.

For the architect or planner seeking to apply the outlined methods, the task remains formidable. Meteorological data of the quality employed by Olgyay in his demonstrations are not commonly available; for example, air temperatures are generally given as daily average maximum or minimum, whereas Olgyay makes use of hourly averages in his work. Similarly, radiation, humidity and wind data are commonly published in architecturally unusable form. The data shortage is always most acute in tropical regions where complete information is most urgently needed if reasonably comfortable conditions are to be achieved without unnecessary recourse to diffuse and wasteful land planning or to mechanical cooling and ventilating plant. Until such time as the compilation of more sophisticated data becomes a fact, the architect, having absorbed the lessons in Olgyay's book, must still have the capacity for a fair measure of seat-of-the-pants design, based upon incomplete data and his own and others' accumulated experience.

In addition to enumerating an author's main contributions, a review must point out his sins. For this book, certainly, the greatest sin is one of omission. The author must have realised the danger of writing a thorough book on a special aspect of design in which virtually no mention is made of the non-climatic bases of design, both functional and intangible. It is predictable that by this omission he has assured the alienation of the minds of the form-giving leaders of the profession and their following.

Perhaps less important, though more annoying to the reader, is the poor co-ordination of text and illustrations; why must one turn three large pages merely to complete a sentence? Many of the charts and diagrams require too much of the reader's time and effort simply to ascertain what information the author is seeking to convey. In several instances illustrations are mis-captioned or misleadingly labelled, slightly off-putting in such a luxuriously produced book. For most of these niggling points the editor and proofreader are to blame.

While this American reviewer had no difficulty in following the many references

NEW THIS MONTH

G. K. BATCHELOR
G. I. Taylor Scientific Papers
Volume III
The third volume of this series contains papers on aerodynamics and the mechanics of projectiles and explosions.
Cambridge University Press *572 pp.* *100s net*

R. BELLMAN
Mathematical Optimization Techniques
A symposium on mathematical optimization techniques and their application to rocketry, communications, decision making, computers, automation and control.
Cambridge University Press for University of California Press
362 pp. *68s net*

A CIBA FOUNDATION VOLUME
Edited by Gordon Wolstenholme
Man and His Future
Eminent scientists consider problems relevant to the development and survival of mankind . . . . . stimulating reading for the educated and enquiring mind.
400 pp. 25s. net
J. & A. Churchill Ltd., 104 Gloucester Place, London, W.1

L. HARRISON MATTHEWS & MAXWELL KNIGHT
The Senses of Animals
A study of the dominant senses of the various groups of living animals and of the anatomical and physiological aspects of the sense organs themselves, for students and field naturalists.
Museum Press 26 Old Brompton Road SW7
240 pp *27/6 net*

H. G. JERRARD & D. B. McNEILL
A DICTIONARY OF SCIENTIFIC UNITS:
Including Dimensionless Numbers & Scales
Contains definitions and historical details of all the units normally used by scientists. Particulars of less widely known units are also included and altogether some 400 are described.
Chapman & Hall Ltd. *197 pps.* *21s. net*

Books *continued*

to US climate, cooling and heating habits and prices, the overseas reader might have wished the author to have maintained the book's generally universal approach throughout, by making cost comparisons in per cent for instance.

When all is said and done, this remains a most useful book. Its worth is greatly enhanced by the fact that it is the only nearly comprehensive methodical work on bioclimatic design at present in existence.

A new look at cytology

Chromosome Marker. By K. R. Lewis and B. John.

Churchill, x + 489 pp., 65s.

THE assumptions that underly the authors' approach to cytology are very much the same as those of Professor C. D. Darlington in *The Evolution of Genetic Systems,* though this book, being much longer, has the space to go deeper. Like Darlington, the authors are not afraid of the unifying hypothesis, nor of making "surprising conjunctions of plant and animal, of genetics and physiology". This will not endear the volume to some groups of cytologists but it is, nevertheless, a very good book indeed, full of unfamiliar facts, lively and stimulating discussion and new views on old problems.

As in the prototype, the breadth of treatment is remarkable and the authors have clearly done a vast amount of reading; a particularly pleasing feature (and one which teachers will no doubt seize upon) is the facility that the authors show in condensing complicated studies into neat and ingenious diagrams.

There are, however, no photographs, a serious omission in view of the extent to which they have replaced line drawings in present-day cytological studies. Different readers will be most interested in different parts; to this reviewer, the discussions of sex-chromosome systems, of the evidence of many-strandedness and polyteny, of the relation between chiasmata and genetical crossing-over and of "the species problem" seemed especially enlightening. It was, on the other hand, surprising to find no reference to secondary pairing in polyploids or to "affinity"; nor to the work of Brown and Zohary on *Lilium*—surely one of the best available analyses of chiasmata crossing-over relationships. One may regret also the decision not to treat the thorny problem of the mechanism of crossing-over, especially as it relates so closely to the more purely cytological question of many-strandedness.

Good as the book is, it is not without defects, mainly of style and presentation. The style is inhomogeneous; some parts are lucid but many long stretches are tediously affected, plain arguments being tricked out with epigrams, *facetiae* (even bad puns), needless quotations and classical references. Furthermore, the authors love vocables which, as Darlington has remarked, exist only in "books and in the memories of over-learned men": lateral multiplicity, distinctional disjunction, chromaticity, pycnosity and amphidiploidising are samples. Nor are sheer errors of spelling or proof-reading wanting: the reviewer counted 42 without trying very hard. These criticisms are not mere pedantry: they come between the authors and the reader and cloud both understanding and enjoyment. It takes a very good writer indeed to control an epigrammatic style with wit, lucidity and elegance.

The book is well made, though the review copy had some creased pages. The cover—once the dust-jacket has been removed—is exceptionally attractive.

N. W. SIMMONDS

Twentieth-century approach to philosophy of science

An Introduction to the Philosophy of Science. By Arthur Pap.

Eyre and Spottiswoode, 444 + xiii pp., 70s.

IT IS A sign of the development and increasing acceptability of philosophy of science courses, especially in the United States, that several comprehensive textbooks are now available, of which the present work by Arthur Pap is the latest to be published in England. Pap is concerned in his preface with the relation between philosophy of science and epistemology in the traditional sense. He finds no radical distinction of problems between them, but rather of illustrative materials used, and considers that, "the philosophy of science course presents a singular opportunity to clear the philosophy classroom of the atmosphere of venerable antiquity and historical erudition and to think about philosophical problems 'from scratch'" (p. viii). In this spirit he carries out thorough investigations into the meaning and verifiability of scientific statements; the relations between mathematics, logic, and experience; induction and probability; causality and laws of nature; explanation and justification; together with specialised applications in geometry, physics, biology and social science. The method throughout is to call to the aid of philosophical discussion all the developments of modern logic and mathematics which have become the essential tools of his trade for the philosopher of science. Philosophy of science is here begun not so much "from scratch" as from the standpoint of the twentieth-century logician, and the expositions of the necessary technical details are for the most part clear and terse, and the references adequate.

The book is posthumously published, having been completed only a few months before the author's tragically early death at the age of 38. It includes an epilogue by Brand Blanshard of the Yale Philosophy Department, where Pap spent his last four years. Pap already had five original books and many papers to his credit, and had become known as a brilliant expositor and sometimes a sharp critic of the point of view broadly called logical empiricism, especially in the field of philosophy of science.

This book must be judged mainly, however, by its success as a textbook, and in its careful analyses it is inevitable that one should miss the flashes of unconventionality and insight which characterise the author's earlier work. There is plenty of controversy in the book, but it is controversy within the agreed rules; the usual moves are made and we get no surprises and no sense of the excitement of a rapidly developing new subject. It is not a book to awaken interest in the philosophy of science, but rather one for the serious student to work carefully through, and then to keep beside him for reference.

MARY HESSE

Other books received

Mutations and Polyploidy in Plant Breeding.
New English Library, 3s. 6d.
Advances in Computers—Vol. 3. Edited by F. L. Alt and M. Rubinoff.
Academic Press, 86s.
Measuring the Universe. By Henry Brinton.
Methuen & Co., 15s.
Classics in Logic. Edited by Dagobert D. Runes.
Philosophical Library, $10.00.
Biological Receptor Mechanisms Symposia No. 16. Edited by J. W. L. Beament.
Cambridge University Press, 50s.
Space Medicine. By Ursula T. Slager.
Prentice-Hall, 84s.
Cohomology Operations—lectures by N. E. Steenrod. Revised by D. B. A. Epstein.
Princeton University Press/Oxford University Press, 24s.
Composition Methods in Homotopy Groups of Spheres. By Hirosi Toda.
Princeton University Press/Oxford University Press, 36s.
History of Hindu Mathematics—Parts I and II. By B. Datta and A. N. Singh.
Asia Publishing House, 42s.
Group Theory—The Application to Quantum Mechanics. By P. H. E Meijer and E. Bauer.
North-Holland Publishing Co., 60s
Elementary Particles and Cosmic Rays. By Alladi Ramakrishnan.
Pergamon Press, 100s.
Rock-forming Minerals—Vol. 2. By W. A. Dee, R. A. Howie and J. Zussman.
Longmans, Green & Co., 95s.
Use of Radioisotopes in Animal Biology and the Medical Sciences. Edited by the International Atomic Energy Agency.
Academic Press, 115s.
The Language of Science. By William Gilman.
English University Press, 21s
Social Evolution. By Gordon Childe.
Fontana, 6s.
Naming the Living World. By T. H. Savory.
English University Press, 12s. 6d
Light. By R. W. Ditchburn.
Blackie, 75s.
Engineering Metalwork Technology. By W. J. Morgan.
University of London, 16s.
Theory of Lubrication. By N Tipel.
Oxford University, 100s.
Interstellar Matter in Galaxies. By L. Woltjer.
W. A. Benjamin, Inc., $11 75
The Photosynthesis of Carbon Compounds. By Melvin Calvin & J. A. Bassham.
W. A. Benjamin, $6.00.
The Nature of Comets. By N. B. Richter.
Methuen & Co., 63s.
Lassers Generation of Light by stimulated Emission. By B. A. Lengyel.
John Wiley & Sons, 55s.
Fluid Mechanics. By M Manohar.
Asia Publishing House, 55s
The Mathematics of Servomechanisms. By J. L. Douce.
English University, 25s.
Tudor Economic Problems. By Peter Ramsey
Victor Gollancz Ltd, 13s. 6d.

CONTRIBUTORS

Alfred Charles Bernard Lovell (*Soviet aims for astronomy and space research*) is Professor of Radio Astronomy in the University of Manchester and Director of the Nuffield Radio Astronomy Laboratories at Jodrell Bank; he was knighted in 1961. He was born in 1913 and educated at Kingswood Grammar School and the University of Bristol. Professor Lovell was elected into the Royal Society in 1955, and was awarded the Society's Royal Medal in 1960. The most recent of his publications are his BBC Reith Lectures on *The Individual and the Universe* in 1958, and his Gregynog Lectures on *The Exploration of Outer Space* in 1961. Sir Bernard is married and has five children; he lives at Swettenham in Cheshire and enjoys cricket, gardening and music. (*pages* 174, 175)

Cyril Ernest Phillips (*Why do we still get fatigue failures?*) is Superintendent of the Materials Group at the National Engineering Laboratory, East Kilbride. In October he becomes one of the five visiting professors recently appointed from NEL at the Royal College of Science and Technology, Glasgow. Mr Phillips spent over 20 years with the National Physical Laboratory before moving to Scotland in 1951. He is 59, married, and spends as much time as possible walking in the high Scottish moors.

Norman Edward Frost (*co-author*) is 40 and Head of the Fatigue, Wear and Stress Analysis Division of the Materials Group at NEL. His early experience was gained with Rolls-Royce; he joined the National Physical Laboratory in 1948 and moved to Scotland in 1951. Mr Frost's researches lie in the strength of materials, and particularly in fatigue problems in metals. He is married with one son and lives in East Kilbride. (*pages* 178-180)

George Michael Blackburn (*Nature's other greens*) is a demonstrator in the University Chemical Laboratory, Cambridge. His field is the chemistry of natural products, and he writes "Highlights" for *Chemistry and Industry*. Dr Blackburn was educated at the Universities of Cambridge and Nottingham, and is a Fellow of Fitzwilliam House, Cambridge. He is 29, married with one daughter, and a "mid-fi" enthusiast and sometime organist; he also enjoys climbing mountains. (*pages* 182-184)

Sibte Hasan Zaidi (*The challenge of experimental medicine*) is Head of the Division of Experimental Medicine at the Central Drug Research Institute, Lucknow, a post he has held since 1955. He specialises in pneumoconiosis and its relationship with tuberculosis, and he is also conducting researches on experimental coronary thrombosis and investigating the peptic ulcer. Dr Zaidi is finishing a book on *Experimental Pneumoconiosis* and is author of a chapter on *Experimental Medicine* for a textbook on medicine to be published in India. He is 45, lives in Lucknow and paints in his free time. (*pages* 192-194)

Ronald Brown (*Colour television for Europe*) is a writer and journalist in the field of electronics, and the editor of *British Electronic Instruments Guide*. He was previously with Marconi as a development engineer. Mr Brown is now chiefly concerned with market research surveys and with surveys of current techniques for industrial firms and for publishers. He is 34, married, and lives at Oxted in Surrey. He enjoys sailing, gardening and making forays into military history, science and government in his spare time. (*pages* 196, 197)

Tudor G. Ingersoll (*The right architecture for the climate*) is Senior Tutor in the Department of Tropical Studies at the Architectural Association. (*page* 203)

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OFFICIAL APPOINTMENTS

UNIVERSITY OF ADELAIDE

invites applications for appointment to the following posts:

In the Faculty of Science:
READER IN PURE MATHEMATICS
SENIOR LECTURER IN MATHEMATICAL PHYSICS
LECTURER IN ORGANIC CHEMISTRY
In the Faculty of Engineering:
LECTURER IN ELECTRICAL ENGINEERING

Salary Scales: Reader £A3000-100-3300, Senior Lecturer £A2450-110-3000; Lecturer £A1675-100-2450; with superannuation on the F.S.S.U. basis. The initial salary in respect of each appointment may be fixed within the appropriate scale in accordance with the successful candidate's qualifications and experience. See also the Statement referred to below.

Further Information: A potential candidate for any post should seek from the Registrar of the University or from the Secretary, The Association of Commonwealth Universities (Branch Office), Marlborough House, Pall Mall, London, S.W.1, the following documents: (i) **General Conditions of Appointment**, which include particulars of tenure, superannuation, removal expenses, invalidity and study leave: and (ii) a **Statement** giving further particulars of each post and of such matters as help in housing, conference grants and special support for research.

The University will gladly supply any further information desired on request to the Registrar.

Applications, in duplicate, should give the information listed in the final paragraph of the General Conditions of Appointment, and should reach the Registrar, The University of Adelaide, Adelaide, South Australia, not later than **September 9, 1963.**

ROYAL MILITARY COLLEGE OF SCIENCE

requires Senior Lecturers or Lecturers in Mechanical Engineering.

DUTIES: Teaching at University level. The successful candidates will lecture to degree courses and specialised courses and assist with laboratory classes. There are extensive well-equipped laboratories. Research is encouraged and work would be suitable for publication and submission for higher degree.

QUALIFICATIONS: First or second class Honours degree or equivalent in any Branch of Mechanical Engineering: and, if possible, membership of one of the major professional bodies.

SALARY: Senior Lecturer, £1,438 to £1,772: Lecturer, £791 to £1,309. Grading and starting pay, which may be above the minimum in either grade, will depend on age, post-graduate experience and National Service. Superannuation under F.S.S.U. Prospects of permanency and promotion. Residential accommodation for single man, prospects of house for married man.

Further particulars and forms from the Registrar, Royal Military College of Science, Shrivenham, Swindon, Wiltshire. (5.)

THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

(Faculty of Technology in the University of Manchester)

Applications are invited for a LECTURESHIP IN PAPER SCIENCE with the title and status of Lecturer in the University of Manchester.

Candidates should possess a good Honours degree in Science or Technology. A graduate in Science or Technology, preferably with industrial experience and interested in research work, is required for the vacant Lectureship in Paper Science in a department moving into a new building in October, 1963. Salary on scale: £1250 x £60-£1670 x £80-£2150 per annum, merit bar-line £1830. Superannuation under the F.S.S.U. Family allowance. Some private consulting is normally permitted.

Conditions of appointment and forms of application may be obtained from The Registrar of the College, The Manchester College of Science and Technology, Sackville Street, Manchester, 1, to whom applications must be returned by Saturday, 17th August, 1963.

NATIONAL COLLEGE FOR HEATING, VENTILATING, REFRIGERATION AND FAN ENGINEERING

at the Borough Polytechnic,
Borough Road, London, S.E.1

Director: James E. Garside, M.Sc.Tech., Ph.D., F.R.I.C., F.I.M., F.Inst.F.
Head of College: David R. Scott, M.Sc., Ph.D., F.Inst.P., M.Inst.R., A.M.I.Min.E., A.M.I.H.V.E., A.M.E.M.E.

The Governors invite applications for the following vacancies created by the continued expansion of the National College.

Principal Lecturer in Environmental Studies

The applicant should have had a wide experience in the scientific study of the indoor and outdoor environment of buildings with the object of achieving satisfactory thermal conditions. Experience in assessing physiological and psychological response to environmental factors would be an advantage.

A higher degree is essential for this post and teaching experience would be an additional qualification.

In addition to lecturing duties the successful candidate will be required to assume responsibility for the design of an environmental room and to assist the Head in general administration of the College.

Senior Lecturer in Heating

Applicants must have had appropriate experience in Mechanical Engineering and have an intimate knowledge of the thermal behaviour of buildings and the environmental conditions which must be provided in them. They must have specialised experience of the design and installation of heating systems and hot water services.

A higher degree and corporate membership of an appropriate professional institution are essential for this post and teaching and/or research experience would be additional qualifications.

Lecturer in Heating

Applicants must possess a university degree in Mechanical Engineering and either corporate membership of an appropriate professional institution plus experience in the design and installation of heating systems and hot water services or a higher degree in Heat Transfer. A successful candidate in the latter category will be provided with facilities for suitable practical training.

Lecturer in Instruments and Controls

Applicants must possess a university degree in Engineering or Science and have had practical experience in the thermal control of environment. Teaching and/or research experience would be additional qualifications.

Assistant Lecturer in Industrial Heat Transfer

The applicant should have a university degree in Science or Engineering and industrial or research experience in Heat Transfer.

SALARY SCALES

Principal Lecturer:	£2,175 x £65-£2,370
Senior Lecturer:	£1,955 x £55-£2,175
Lecturer: ..	£1,730 x £45-£1,955
Assistant Lecturer:	£890 by annual increments to £1,510

Application forms and further particulars may be obtained from the undersigned.

Fredk. J. Packer
Secretary and Clerk to the Governors

THE UNIVERSITY OF SHEFFIELD

Applications are invited for a post of LECTURER in ELECTRICAL ENGINEERING, to begin duties on 1st October, 1963, or as soon as possible thereafter. An interest in control systems, analogue computers, electrical power or electrical machinery would be welcomed. Some industrial experience would be regarded as a valuable asset. Initial salary according to qualifications and experience on the scale £1,250 x 60—1,670 x 80—£2,150, with F.S.S.U. provision and family allowance. A grant towards removal expenses will be made. Further particulars may be obtained from the Registrar, to whom applications (four copies), including names and addresses of two referees, should be sent by 12th August, 1963.

U.N.E.S.C.O. WARANGAL REGIONAL ENGINEERING COLLEGE

Warangal, Andhra, Pradesh, India

Applications are invited for:
(i) SPECIALIST in THERMAL MACHINERY
(ii) SPECIALIST in PRODUCTION ENGINEERING
(iii) SPECIALIST in APPLIED MECHANICS
(iv) SPECIALIST in ELECTRIC POWER GENERATION, TRANSMISSION and DISTRIBUTION
(v) SPECIALIST in ELECTRIC MEASURING INSTRUMENTS and MEASUREMENTS
(vi) SPECIALIST in APPLIED MATHEMATICS
(vii) SPECIALIST in PHYSICS

QUALIFICATIONS: (i) to (v) Good hons. degree in appropriate branch of engineering: several years' experience in teaching, research and industry or professional work. (vi) to (vii) Good hons. degree; several years' teaching experience at undergraduate and postgraduate level and in research.

DURATION of APPOINTMENT: 2 years in first instance.

SALARY and ALLOWANCES: (i) to (vii) equivalent to U.S. \$10,650 (£3,804) p.a., plus post adjustment \$312-\$468. Plus assignment allowance \$1,100-\$1,400 p.a. All subject to installation allowance. Dependency allowances for wife and children. Service Benefit: 8% of basic salary on termination of assignment. Salary and allowances all free of Income Tax.

Application forms and further information from Council for Technical Education and Training for Overseas Countries, 12 Lincoln's Inn Fields, London, W.C.2. Closing date 20th August 1963.

UNIVERSITY OF WALES UNIVERSITY COLLEGE OF SWANSEA

Department of Engineering

Applications are invited for the post of RESEARCH ASSISTANT IN CIVIL ENGINEERING. The salary attached to the post will be not less than £1,000 per annum together with family allowances where applicable. The appointment will date from October 1, 1963, and will be for a period of two years in the first instance.

The field of research is concerned with the development of a high temperature photoelastic strain gauge using ceramic elements.

Applicants should have a higher degree or equivalent research experience in experimental physics or engineering.

An interest in optics and crystallography or experimental stress analysis would be an advantage, and good practical design experience is essential.

Applications together with the names of two referees should be sent to the Registrar, University College of Swansea, Singleton Park, Swansea, not later than **Wednesday, July 31, 1963.**

VICTORIA UNIVERSITY OF WELLINGTON New Zealand

Senior Lecturer and Lecturer in Physics

Applications are invited for the above mentioned posts in the Department of Physics.

The salary for a Senior Lecturer will be £1,750 rising to £2,000 per annum and for a Lecturer £1,250 rising to £1,700 per annum, initial salary being determined in accordance with the qualifications and experience of the appointees.

Approved fares to Wellington will be allowed for an appointee, his wife and his dependent children. In addition, actual removal expenses will be allowed within specified limits.

Further particulars and information as to the method of application should be obtained from the Secretary, Association of Commonwealth Universities (Branch Office), Marlborough House, Pall Mall, London, S.W.1.

Applications close in New Zealand and London on **15th October, 1963.**

MASSEY UNIVERSITY COLLEGE OF MANAWATU
Palmerston North, New Zealand

Chairs in Biological Science (2)

Applications are invited from persons suitably qualified in Biochemistry, Botany, Microbiology or Zoology for chairs in the newly established science faculty at the College. The salary attached to a chair is £2,800 per annum.

It is intended in the first instance to appoint two professors, these appointments to be followed in the near future by further chairs in biological science and in physical science. Applicants should note that the type of development envisaged for biological teaching and research is one which will emphasize those principles common to all living matter and lead to an integration of the disciplines concerned.

The first appointees may be required initially to assume responsibility for more than one of the foregoing subjects, for courses in first year science and for certain courses in the associated applied fields of Agricultural and Horticultural Science, Food Technology and Veterinary Science

A building programme is under way which with accompanying expansion of staffing should enable the first advanced pure science courses (Stage II) to be offered in 1966, followed by Stage III and honours courses in succeeding years.

Further details of this position, the College, and conditions of appointment are available from the Secretary, Association of Commonwealth Universities (Branch Office), Marlborough House, Pall Mall, London, S.W.1, or from the Registrar of the College.

Applications close, in New Zealand and London, on **30th September, 1963.**

UNIVERSITY OF ST. ANDREWS

Applications are invited for the following posts tenable in the Faculty of Science in Queen's College, Dundee, in the University of St. Andrews, commencing 1st October 1963 or such later date as may be arranged:—

Lectureship in Statistics
Assistantship in Mathematics

Salary scales: Lectureship—£1250 x £60 to £1670 (efficiency bar) x £80 to £2150. (Placing according to qualifications and experience)
Assistantship—£1000 x £50 to £1150 (appointment for three years with possibility of continuation for fourth and final year).

F.S.S.U.: family allowance: grant towards furniture removal expenses. Applications (6 copies) containing the names of three referees to be lodged not later than 17th August, 1963, with the Secretary of the University at Queen's College, Dundee, from whom further particulars may be obtained
July 1963.

VICTORIA UNIVERSITY OF WELLINGTON
New Zealand

Professor of Theoretical Physics

The Council of the Victoria University of Wellington proposes to appoint a Professor of Theoretical Physics within the Department of Physics and invites applications from suitably qualified persons.

The salary will be at the rate of £2,800 per annum. Approved fares to Wellington will be allowed for the appointee, his wife and his dependent children: in addition, actual removal expenses will be allowed within specified limits.

Further particulars and information as to the method of application may be obtained from the Secretary, ASSOCIATION of COMMONWEALTH UNIVERSITIES (Branch Office), Marlborough House, Pall Mall, London, S.W.1.

Applications close in New Zealand and London on **15th October, 1963.**

UNIVERSITY OF IBADAN, NIGERIA

Applications are invited for Senior Lectureship in Department of Physics. Preference given to a candidate qualified to lead and develop research in applied geophysics or the physics of thunderstorms, the first of these being given higher preference. Appointment on secondment considered. Salary scale: £2,275 x 75-£2,575 p.a., in the case of a candidate with exceptional qualifications and experience it may be possible to offer a higher salary scale. Passages paid for appointee, wife and up to five children under 11 years, on appointment, approved overseas leave, and termination, where applicable. F.S.S.U. Children's and car allowances. Part-furnished accommodation at rent not exceeding 7% of salary. Detailed applications (6 copies), naming 3 referees by 25 August, 1963 to Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1, from whom further particulars may be obtained.

RESEARCH OFFICER—HEAD OF ANIMAL HUSBANDRY DIVISION

East African Common Services Organization

The Department of Technical Co-operation invites applications for the post of Research Officer, Head of Animal Husbandry Division in the East African Agricultural and Forestry Research Organization, Muguga, Kenya.

Duties: To be responsible to the Director for the initiation and carrying out of research programmes on important problems of animal management in East Africa. Some of this work will probably be done in co-operation with animal research workers in the countries of East Africa.

Qualifications: Candidates under 50 years of age should possess a good Honours degree, preferably in sciences which include animal physiology and biochemistry and have experience in initiating research programmes in the field of animal husbandry and management.

Terms of Appointment: Appointment on contract/gratuity terms for one or two tours of 2 years. Salary: S.P.S.O. £3,125: or P.S.O. £2172 x 78-£2328 x 60-£2448 x 72-£2808 with a gratuity of 25% of total salary earned. Education allowances: Free passages. Furnished accommodation available at a low rental. Generous Leave.

Applications giving full name and brief particulars of qualifications and experience to Director of Recruitment, Department of Technical Co-operation, Sanctuary Buildings, Great Smith Street, London, S.W.1. Quote D45RC. 217/383/01.

D.S.I.R.

National Physical Laboratory
Teddington, Middlesex

Senior Scientific Officer Scientific Officer Electronic Engineers or Physicists required to work in collaboration with other physicists studying gamma ray dosimetry and measurement of neutrons and of radioactivity. The officers appointed would be responsible for advanced circuit design, applying semi-conductor techniques and devices to problems of rapid particle counting, data handling and processing, and very low current measurement. Some familiarity with computer logical design would be an advantage.

QUALIFICATIONS: 1st or 2nd class Hons. degree in Physics or Engineering or equivalent. Minimum age 26 for Senior Scientific Officer and at least three years' post graduate experience.

SALARY: Scientific Officer — £831-£1,359
Senior Scientific Officer £1,488-£1,832

APPLICATION FORM from Director at above address quoting 121YV. Closing date 24th August 1963. (5.)

BEDFORDSHIRE EDUCATION COMMITTEE

Brewer's Hill County Secondary School, Dunstable, Beds.

Required as from 1st September, 1963, Laboratory Technician, duties include maintenance of apparatus and laboratories, preparation of solutions and demonstration experiments in Biology, Chemistry and Physics. Salary £270 per annum at 16 years, £470 per annum at 22, £505 per annum at 23, rising to a maximum of £655. At age 18 superannuation under local Government Superannuation Scheme.

Hours 9 a.m. to 5 p.m. daily, 9 a.m. to 12 noon Saturdays. Apply by letter to the Headmaster stating any qualifications or experience and giving names of two referees who can speak with knowledge of the candidate. Candidates with no previous experience of this kind of work will be considered if they are adaptable.

BEDFORDSHIRE EDUCATION COMMITTEE

Biggleswade County Secondary School, Biggleswade, Beds.

Required as from 1st September, 1963, Laboratory Technician, duties include maintenance of apparatus and laboratories, preparation of solutions and demonstration experiments in Biology, Chemistry and Physics. Salary £270 per annum at 16 years, £470 per annum at 22, £505 per annum at 23, rising to a maximum of £655. At age 18 superannuation under local Government Superannuation Scheme.

Hours 9 a.m. to 5 p.m. daily, 9 a.m. to 12 noon Saturdays. Apply by letter to the Headmaster stating any qualifications or experience and giving names of two referees who can speak with knowledge of the candidate. Candidates with no previous experience of this kind of work will be considered if suitably qualified.

APPOINTMENTS AND SITUATIONS VACANT

NEW ZEALAND
Agriculture Department

Applications are invited for the undermentioned vacancy:

Vacancy B13/2/19/2137: Scientific Officer, Diagnostic Section, Taieri.

Salary: Up to £1,365 a year with further promotion on merit.

Qualifications desired: A University degree in Science with Chemistry as a major subject.

Duties: Analysis of animal tissues for trace elements and poisons, and providing a service in general diagnostic toxicology. An appropriate period of training will be given at Wallaceville Animal Research Station.

Passages: Fares for appointee and his wife and family, if married, will be paid.

Incidental Expenses: Up to £35 for a single man and £100 for a married man can be claimed to cover the cost of taking personal effects to New Zealand.

Application forms and general information are available from the High Commissioner for New Zealand, New Zealand House, Haymarket, London, S.W.1, with whom applications will close on 23 August, 1963.

Please quote reference B13/2/19/2137 when enquiring.

ST. BARTHOLOMEW'S HOSPITAL
London, E.C.1

A vacancy arises for a Research Assistant in the Department of Medical Statistics. This work will include the analysis of clinical and laboratory data in connection with research projects carried out over a wide field in the hospital and Medical College. The post should provide a useful background for anyone making a career in Medical Statistics or an allied subject. Candidates should hold a degree in a scientific subject and have some knowledge of statistics. The appointment is for one year in the first instance and applications giving the names of two referees should be submitted to the Clerk to the Governors as soon as possible. The salary for this appointment is from £664 per annum plus London Weighting and the starting point will be dependent on qualifications and experience. Please quote reference AC/195.

BP has the following vacancies in its Biological Research Division at Grangemouth, Stirlingshire:

MICRO-BIOLOGIST

Aged under 35 years and possessing a degree or its equivalent in Micro-biology.

BIO-CHEMIST

Applicants should be under 35 years of age and have a degree in Bio-chemistry or a general degree in Science with Bio-chemistry as one of the subjects.

Conditions of service are excellent and include an Assisted House Purchase Scheme and a non-contributory Pension Fund. Write giving brief details of age, qualifications and any previous experience, quoting reference H.6207, to Box 7321, c/o Hanway House, Clark's Place, E.C.2.

THE UNIVERSITY of MANCHESTER

Applications are invited for the post of Experimental Officer in the Department of Chemistry in the Faculty of Science, to be concerned with preparative work involving the synthesis of inorganic molecules containing isotopically labelled atoms. Salary range: £880 x £40 to £1,200 per annum. The initial salary will be according to qualifications and experience. Duties to commence October 1st, 1963. Contributory superannuation scheme. Applications should be sent not later than September 7th, 1963, to the Registrar, the University, Manchester, 13, from whom further particulars and forms of application may be obtained.

LABORATORY STEWARD required for Biophysics Department and M.R.C. Research Unit in new laboratories. Applicants should be aged 30-45. Special consideration given to candidates with comprehensive knowledge of laboratory organisation and ability to co-operate with academic and technical staff. Previous experience in either a Physics or Biochemical laboratory advantageous. Apply in writing stating qualifications and experience to: Secretary, King's College, Strand, W.C.2.

TECHNICAL ASSISTANT required for Consultant's laboratory in the London area dealing with a wide range of food processing problems. Industrial experience desirable. Applications to Box C884 NEW SCIENTIST.

CENTRAL ELECTRICITY RESEARCH LABORATORIES

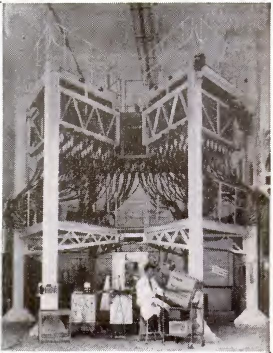
Leatherhead, Surrey

GRADUATES

are invited to apply for appointments in the High Voltage Division where research is carried out in the fields of high-power transmission, gas discharges and electrical engineering. These include the study of such problems as the dielectric properties of polymers; outdoor insulation; radio and television interference; current ratings of line conductors and fittings; lightning and switching surges, magnetohydrodynamics, corona and high current surge phenomena.

The following are typical of the vacancies existing in the Division:

1. **PHYSICISTS or CHEMISTS** to study polymers of potential interest as insulants. The work will fall broadly into the following types of basic investigation:
   - (*a*) The electrical and physical properties of polymers in relation to their structure and composition.
   - (*b*) The degrading changes produced in polymers by pyrolysis, oxidation and various electrical discharges.
2. **PHYSICISTS or ELECTRICAL ENGINEERS** to work in a team concerned with the development of compressed gas as an insulating medium.



HIGH ENERGY CAPACITOR BANK

3. **PHYSICISTS** to examine the fundamentals of breakdown processes in gases using modern diagnostic techniques.
4. **PHYSICISTS, MATHEMATICIANS or ENGINEERS** to examine theoretically magnetohydrodynamic generator systems.

● **For those who have recently completed Honours degrees or are completing post-graduate courses the initial salary will be in a range rising to £1,500 per annum. There are also posts available for more experienced graduates on a scale rising to £2,220 per annum. In both cases there are excellent prospects of early promotion to higher salary ranges.**

Publication of original work is encouraged, excellent laboratory facilities are available and some assistance with housing may be possible in certain cases.

Applications stating age, qualifications, experience, present position and salary to the Personnel Officer (Headquarters), 24-30, Holborn, London, E.C.1.

Quote Ref. NS. 222

D.S.I.R.

National Engineering Laboratory
East Kilbride, Glasgow

ASSISTANT EXPERIMENTAL OFFICER for electrical engineering duties including preparation of power distribution and control circuit diagrams, specification of a.c. and d.c. control gear in low and medium voltage ranges and development of original control circuits for experimental work.
QUALIFICATIONS: S.C.E. (or equivalent) in five subjects, including three in the Higher Grade (two in scientific or maths subjects). Over age 22—Degree, Dip. Tech., H.N.C. or equivalent.
EXPERIENCE: Knowledge of IEE regulations and ability to prepare mechanical engineering drawings an advantage.
SALARY: £490 (age 18)—£858 (age 26)—£1,053.

Houses are available for married staff. Prospects of permanent pensionable post.

Forms from Director at above address. Closing date 12th August 1963. (5.)

RADIOBIOLOGY UNIT, Histology Technician required for research programme concerned with the effects of radiation on tissues. Interesting and responsible work. Salary on the scale £675 x £25-£825, commencing point depending on age and experience. Apply, giving names of two referees, to the Secretary, The Medical College of St. Bartholomew's Hospital, West Smithfield, E.C.1.

TECHNICIANS required in NUTRITION Department, one with A.T.A. qualifications for work in Mouse room, and one with qualifications in Chemistry and preferably with biochemical experience for work in biochemical laboratory. Applications, with names of referees, to the Secretary, Queen Elizabeth College, Campden Hill Road, W.8.

SCIENTIFIC CIVIL SERVICE

Interesting and rewarding careers in pensionable posts as (a) EXPERIMENTAL OFFICERS or (b) ASSISTANT EXPERIMENTAL OFFICERS are offered to a number of men and women with qualifications in MATHEMATICS, PHYSICS, METEOROLOGY, ENGINEERING, CHEMISTRY and BIOLOGY.
Candidates should hold H.N.C., Diploma of Technology, or a University Degree, although some candidates under age 22 will be considered with lower qualifications down to the minimum requirement of G.C.E. A level passes in 2 scientific or mathematical subjects (or equivalent).
Application forms for this competition must reach the Commissioners by 13th September, 1963, when recruitment to permanent posts in this Class will cease until the Spring competition of 1964.
Candidates must, on 31.12.63 be at least 26 and normally under 31 for (a), and at least 18 and normally under 28 for (b).
National Salary Scales (a) £1,164-£1,431 (starting salary may be above minimum). (b) £490 (at 18) to £858 (26 or over) rising to £1,053. Promotion prospects. Generous facilities for further education.
Write Civil Service Commission, 23 Savile Row, London, W.1, for application form, quoting **S/579-580 63.**(3)

WESTFIELD COLLEGE

University of London

Technician required for Physics Department, salary £570-£790. Applications (two copies) giving age, qualifications and two referees to the College Secretary, Westfield College (University of London), London, N.W.3.

ST. MARY'S (R.C.) COLLEGE
Strawberry Hill, Twickenham

Applications are invited from suitably qualified men or women for the following posts:—

LECTURER IN PHYSICS
LECTURER IN CHEMISTRY

Applicants must be graduates with some teaching experience. Pelham Scale with London Allowance. Successful applicants will be expected to take up duties as soon as they can be released to do so. Applications (no forms) to the Principal to arrive not later than August 31st.

UNIVERSITY OF KEELE

Technicians required to help with teaching and research work in Physics Department. No previous experience in teaching laboratories required but applicants should have normal technical qualifications and a real interest in Physics, and any acquaintance with work on gas discharge or radar techniques would be an advantage. Salary in scale £540-£745 p.a. with additional emoluments for specific qualifications, and 24 days' paid holiday. Further particulars can be obtained from the Professor of Physics, The University, Keele, Staffs, to whom applications should be submitted by 17th August, 1963.

SCIENTIFIC PUBLISHERS (LONDON) have a full-time Editorial vacancy in an interesting documentation project for a woman (older woman preferred) with Chemistry degree or equivalent. Some knowledge of German an advantage. Salary £1,250 to suitable applicant. Full particulars to Box C882 NEW SCIENTIST.

AUSTRALIAN ATOMIC ENERGY COMMISSION

RESEARCH ESTABLISHMENT, SYDNEY, N.S.W.

CHEMISTS, MATHEMATICIANS, ENGINEERS, METALLURGISTS, PHYSICISTS AND BIOCHEMISTS

are invited to apply for the following vacancies:

Pstn. R.15—RO/SRO Physics Division, Theoretical Reactor Physics Group. To carry out reactor physics investigations and surveys of reactor systems using a large digital computer. Ph.D. or research experience in relevant fields of physics and mathematics.

Pstn. R.23—SRO/PRO Physics Division, Safety Group. To work on problems associated with reactor dynamics and the safety of systems involving nuclear fuel. Research experience required in relevant fields of physics and mathematics.

Pstn. R.69—SRO/PRO Health and Safety Division, Environmental Studies Group. To be leader of this Group which is concerned with the measurement of radio-activity in the environment and the mechanisms by which radio-activity is distributed and incorporated and in particular to investigate the burial of active wastes, atmospheric dilution and the dispersal of liquid effluent in tidal estuaries. Degree in physics, geology, meteorology or other appropriate subject with research experience in a responsible position in one of the fields of interest.

Pstn. R.62—SRO/PRO Health and Safety Division, Radiation Physics Group. To be leader in this group which covers a wide range of subjects in the fields of radiation dosimetry, especially neutron dose and spectrum measurement, the interaction of radiation (neutrons and positive ions) with matter, the detection and spectrometry of low levels of radio-activity and whole body counting. Facilities available include a 3 Mev positive ion accelerator, a 1.3 Mev electron accelerator, HIFAR and a low power reactor and minor radiation sources. Degree in physics with extensive experience in conducting and leading research in neutron or low energy particle physics, or a closely related field.

Pstn. R.93—RO/SRO General Nucleonics Division, Spectrometry Group. To undertake research in spectroscopy applications and in general work of Group. Laboratories are excellently equipped with spectrographs, U.V., visible, infra-red and flame spectrophotometers and X-ray and mass spectrometers. Degree in chemistry with good working knowledge of electronic and/or optical instruments.

Pstn. R.53—RO Isotopes Division, Physics Research Group. The group carries out long term research into the applications of radio-isotopes and radiation in industry and science and also undertakes more fundamental studies on the interactions of radiation with matter. Degree in physics.

Pstn. E.87—Isotopes Production Manager, Isotopes Division, Production Group. Direct all operational aspects associated with the production of standard radioisotope products using established techniques. Supervise staff engaged in the preparation of target materials for neutron irradiation, post irradiation handling, routine activity measurements, remote physical and chemical processing and shipping of a wide variety of radioisotopes of varying activities. Degree in chemistry, chemical engineering, metallurgy or engineering. Previous experience in production of a variety of highly specialised products desirable and control of staff essential.

Pstns. R.71, R.112—EO/RO Health and Safety Division, Radiation Biology Group. The group is concerned with the biological effects of ionizing radiation, particularly early acute effects, and its present activities include studies in enzymology, neurophysiology and the physiology of cell division. Training in either biochemistry or some aspects of cytology preferred. Post-graduate research experience, desirable but not essential, will determine whether EO or RO.

Pstns. R.58, R.107—RO/SRO Materials Division, Chemistry Section. Responsibility of Section is to investigate chemical problems arising from the application of ceramic systems to a H.T.G.C. reactor with present emphasis on the use of beryllium oxide. The work of the Section covers a wide field including studies of gas solid reactions, diffusion in ceramic materials, and of solution chemistry associated with the re-processing of nuclear fuel. Vacancies exist on following projects:

(1) The reactions of oxides and ceramics in aqueous and non-aqueous solutions.
(2) Fundamental aspects of solvent extraction which are relevant to fuel re-processing; and
(3) the application of solvent extraction to the treatment of spent fuel

A degree in physical or inorganic chemistry.

Pstn. R.61—SRO/PRO General Nucleonics Division, Electronics Group. To be responsible for groups working in the following fields of electronics:

(1) development of a variety of electronic measuring and control instruments required in the research activities of the Establishment.
(2) advanced circuit design applying semi-conductor devices to problems of fast nuclear counting, data acquisition and handling, etc.

Degree in Electrical Engineering with research and development experience in general electronic circuit design and pulse techniques. Experience in computer logical design would be an advantage.

Pstn. E.85—EO I/III Isotopes Division, Industrial Research Group. To participate in the Group's activities in the industrial and research applications of radioisotopes which include problems in the field of mechanical and chemical engineering. The Group gives assistance and advice on the use of radioisotopes to Australian industry and science, including field and factory investigations and projects, using radioisotopes. Some country and interstate travel involved. Degree in chemical or mechanical engineering desirable. Knowledge of Australian industry and experience with radio-active materials an advantage.

Pstns. R.98, R.108, E.23—RO/SRO, EO I/III Engineering Research Division, Design and Development Section. Concerned with design and feasibility studies of the H.T.G.C. system, covering such matters as the design of the reactor core, calculation of the reactor characteristics and comparison of the various possible arrangements, design of the associated plant to utilise the heat produced in the reactor and estimation of costs. Engineering qualifications with experience in power plant, heat transfer or mechanical design. Experience in nuclear engineering.

Pstn. R.76—RO/SRO Engineering Research Division, Theoretical Research Section. To formulate and develop methods of solution of nuclear engineering problems within the Nuclear Studies Group which are of concern in the design of H.T.G.C. power reactors. Automatic computing facilities are available. Degree in engineering, physics or mathematics. Experience in nuclear field helpful but prime requirements are engineering background and adequate mathematical ability.

Pstn. R.96—RO/SRO Engineering Research Division, Theoretical Research Section. Within the Applied Mathematics and Computing Group to be concerned with research into numerical methods and computing techniques applicable to the solution of problems encountered within the field of nuclear energy. Degree in mathematics or physics.

Pstn. E.17—EO I/III Engineering Research Division, Theoretical Research Section. Within the Applied Mathematics and Computing Group to be concerned with development of numerical methods and computing techniques applicable to the solution of problems encountered within the field of nuclear energy. Degree in mathematics or physics.

Pstn. R.113—RO/SRO Engineering Research Division, Experimental Research and Development Section. To conduct research into stress and vibration problems related to the reactor core and plant design studies of the H.T.G.C. reactor project. This will involve setting up small experimental facilities and the ability to extend to engineering applications, basic data on ceramics and other materials obtained by the Materials Division. Degree in engineering with experience in stress and vibration analysis and preferably experimental research.

Pstn. R.110—RO/SRO EO I/III Engineering Research Division, Experimental Research and Development Section. To investigate and assess the heat transfer and fluid flow characteristics of various assemblies. Work mainly analytical associated with experimental studies within the group which is concerned with experimental investigation related to heat removal from high temperature gas-cooled nuclear reactors. Degrees in engineering with reasonably sound mathematical ability and preferably with research experience.

Pstn. R.117—RO/SRO EO I/III Engineering Research Division, Experimental Research and Development Section. To assist in development and application of experimental techniques related to fluid flow, heat transfer and stress measurements. Work chiefly concerned with the attainment and measurement of prescribed conditions in experimental rigs in which studies relating to the design of a H.T.G.C. reactor are carried out by model techniques. Considerable ingenuity is required in using such widely diverse techniques as hot wire anemometry, induction heating and flow visualisation under unusual conditions both static and dynamic. Degree in mechanical, electrical or aeronautical engineeering or physics preferably with experience in experimental research.

Pstn. E.8—EO II/III Engineering Research Division, Experimental Research and Development Section. To lead a Group in rig design studies, liaison with engineering services section during the design, procurement and commissioning of major rigs. Responsible for specification, procurement, design, manufacture and commissioning of minor rigs, models and other equipment required by the section, and other work connected with engineering development generally. Engineering degree with experience in operation of complex plant and/or development work preferably on high pressure and temperature plant, rotating machinery, electric heaters and electronic instrumentation.

Pstn. R.118—RO/SRO Engineering Research Division, Evaluation Group. To assist with examination and assessment of various nuclear power systems. These studies will necessarily include physics, thermodynamics and heat transfer, materials, engineering design, operation and safety and economic calculations. Degree in engineering or science and experience in field of nuclear engineering required.

Pstn. E.11—EO I/III Engineering Research Division, Evaluation Group. To carry out detailed technical and cost analyses of components associated with nuclear and conventional power plants. Engineering degree preferably with experience relevant to above.

Pstn. R.120—RO/SRO Engineering Research Division, Applications Group. To study and report on overseas developments in special fields of nuclear energy, such as marine propulsion, desalination of water, the use of nuclear heat in the process industries, and the applications of controlled nuclear explosions. Engineering or science degree with experience in research and development preferably on major plant or process development and with an interest in technical and economic feasibility studies. Experience in nuclear engineering desirable but not essential.

GENERAL

RO = Research Officer £1541/2296
SRO = Senior Research Officer £2426/2751
PRO = Principal Research Officer £3011/3531

These ranges are at present under review. Qualifications for appointments are Ph.D. or equivalent, e.g. 1st or 2nd class honours degree plus proven research experience and ability.

EO I = Experimental Officer I £1376/2231
EO II = Experimental Officer II £2331/2631
EO III = Experimental Officer III £2751/3111

Qualifications for appointment are a degree or diploma or equivalent.

Isotopes Production Manager £2101/2361 or £2491/2751 depending on qualifications and experience. Salary ranges are under review.

Salary on appointment depends upon qualifications and experience. Promotion is by merit and may ultimately go beyond the upper limit of the scale within which the original appointment is made. The cost of living adjustment of £133 is included in all salaries quoted which are in Australian currency.

Fares will be paid to an appointee and his dependent family. Return fares to point of origin will be paid where by arrangement a Research Officer accepts appointment for a fixed term (usually three (3) years).

Requests for application forms, quoting appropriate position number, should be sent to the Scientific Liaison Officer, A.A.E.C., Australia House, Strand, London, W.C.2. The closing date is 6th September 1963.

COMMONWEALTH OF AUSTRALIA

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

DIVISION OF PROTEIN CHEMISTRY

POST-DOCTORAL FELLOWSHIPS IN WOOL UTILIZATION

The Organization's Division of Protein Chemistry located in Melbourne, Victoria, invites applications from Ph.D. graduates for the following Post-Doctoral Fellowships.

TEXTILE SCIENTIST

It is proposed to appoint a Post-Doctoral Fellow to a small group working in the Division of Protein Chemistry on the production of moulded wool felt. In this process the wool is felted directly into various shapes some with patterned surfaces

Applicants should have completed a Ph.D. degree including training in some branch of textile science. Research experience in the production of non-woven fabrics would be an advantage but is not essential.

CHEMICAL ENGINEER

A Chemical Engineer will be appointed to the Division to apply chemical engineering principles to wet processes already in use in the wool textile industry. He will also be required to work with other members of the Division's Processing Group on new methods of processing such as the carbonizing of wool in the presence of detergent, formic acid dyeing of wool and new shrink-resist methods involving deposition of polymers on the fibres.

Applicants should hold a Ph.D. degree in chemical engineering but need not have had previous experience in the textile field.

A wide range of research equipment and facilities are available in the Division.

The Fellowships are offered for a period of 3 years.

SALARY: Commensurate with qualifications and experience: minimum offered £A1816 p.a. up to a maximum of £A2750 p.a. Salary for women will be £A188 p.a. less than corresponding rate for men

Fares paid for the appointee and his dependent family and return fares to point of origin will be provided at the end of the Fellowship. Further particulars supplied on application to:

Mr. P. F. Butler, Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, W.C.2,

to whom applications (quoting Appointment No. 462/180) should be addressed by the **7th September, 1963.**

SENIOR LABORATORY TECHNICIAN required for Science Department. Permanent and Pensionable. Salary scale—£720 x £25 x £795 x £30 x £825. For holders of the City & Guilds of London Institute Science Laboratory Technician's Advanced Certificate, or recognised equivalent, salary scale—£815 x £25 x £940. Apply in writing, giving full details of age, qualifications, experience, etc. to the Secretary, Northern Polytechnic, Holloway Road, N.7.

TECHNICIAN or JUNIOR TECHNICIAN wanted in **BIOLOGY** Department in September. Candidates should have interest in growing plants and in culture of invertebrate animals. Applications, giving age, education, experience and references, to the Secretary, Queen Elizabeth College, Campden Hill Road, W.8.

CAMBRIDGE UNIVERSITY

School of Veterinary Medicine

Research Assistants: Research group studying enteric diseases requires four Veterinary or Science graduates to assist in the following subjects: (i) Virology, (ii) Histopathology (veterinary or medical graduate only), (iii) Chemical Pathology and (iv) Nutrition. It may be possible for suitable persons to read for the Ph.D. degree while holding these posts (except in Virology). Further details from the Administrative Secretary, School of Veterinary Medicine, Madingley Road, Cambridge.

BBC

JUNIOR LABORATORY TECHNICIANS

BBC offers experience and training to young men as junior laboratory technicians in the Equipment Department, based in London. Experience is not essential, but applicants must be able to demonstrate a keen interest in radio and electronics. They must be British subjects, aged 17½ to 20, and hold the G.C.E. at "O" level in five subjects, including English, mathematics and physics, preferably mathematics or physics at Advanced level. An equivalent Scottish or Northern Ireland certificate will be accepted. General training will be given in the laboratories and day release will be granted for approved courses of technical study leading to the O.N.C. and H.N.C. in electrical engineering. College fees will be paid by the Corporation. Salary on appointment at 18 years: £525 p.a. at 19 years: £650 p.a. at 20 years: £765 p.a. and thereafter rising by annual increments of £50 to £1065 p.a. There are prospects of advancement to senior laboratory technician and engineer grades.

Write for application form to

Engineering Recruitment Officer,

BROADCASTING HOUSE, LONDON, W.1

quoting reference 63.E.489 N.Sc.

WANTED

PLANT MANAGER

to be responsible for the operation of an important section of a plant in the Midlands involving quarrying, crushing, grinding calcination and associated operations.

Several years' experience in an equivalent position in the chemical or limestone industries is preferred. Must be strict disciplinarian.

Qualifications H.N.C. or higher. Salary £1100 p.a. or higher depending on experience and qualifications. Applications in strictest confidence to BOX C883 NEW SCIENTIST.

THE UNIVERSITIES OF LIVERPOOL AND MANCHESTER

Joint Nuclear Reactor Project

Applications are invited for the post of DEPUTY REACTOR ENGINEER in connection with the nuclear reactor to be operated jointly by the University of Liverpool and the University of Manchester. The Deputy Reactor Engineer will be concerned with the operation of the entire laboratory, maintenance of plant and equipment, and control of technical staff. Candidates should hold a University degree in Engineering or an equivalent qualification and should have several years' industrial experience; some experience in plant operation would be an advantage.

No previous experience in the nuclear reactor field is necessary, although the candidate would be expected to acquire such specialised knowledge. Arrangements will be made for him to do this in one of the University departments concerned. Initial salary in the range £1,200-£1,400 per annum.

Further particulars may be obtained from the Bursar, The University, Manchester 13. Completed applications should be sent to the Bursar, with the names and addresses of two referees, by 31st August, 1963.

D.S.I.R.

National Engineering Laboratory East Kilbride, Glasgow

Mathematician as Senior Scientific Officer/Scientific Officer required to lead a section of the team providing a mathematical service to the Laboratory. There is scope for original work in such topics as fluid flow, heat transfer, machine tool control, bearing design, stress analysis and in the application of digital computers to them.

QUALIFICATIONS: 1st or 2nd Class Honours degree in Mathematics or Applied Mathematics with experience in the application of numerical analysis and digital computers. Some knowledge of numerical methods is desirable.

SALARY: S.O. £791-£1,309: S.S.O. (over 26, with at least three years' post-graduate experience) £1,438-£1,772.

HOUSING is available for married staff in the New Town.

APPLICATION FORM from Director at above address quoting Ref: E/AQ/030. Closing date 7th August 1963. (5.)

ST. THOMAS' HOSPITAL London, S.E.1

Radiotherapy Department

Physics Technician (Basic or Senior according to qualifications and experience) required to assist in the work of Physics and Isotopes Laboratories

Previous experience in electronics or electrical engineering desirable.

Salary scale: £630—£1,000, plus London Weighting.

For further information application should be made to the Personnel Officer

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THE UNIVERSITY OF SHEFFIELD

Applications are invited for a POSTDOCTORAL FELLOWSHIP in PHYSICAL CHEMISTRY to work on a fundamental study of thermal diffusion in binary liquid mixtures under the direction of Dr. H. J. V. Tyrrell. Appointment for up to three years, salary £900 per annum rising to £1,050 per annum with F.S.S.U. benefits. Applications, giving details of qualifications and the names of two referees, should be sent to the Registrar, The University, Sheffield, 10.

CENTRAL ELECTRICITY GENERATING BOARD SOUTH WESTERN REGION

Western Division

Hinkley Point Nuclear Power Station

Applications are invited for the post of

ASSISTANT CHEMIST

at Hinkley Point Nuclear Power Station, Near Bridgwater, Somerset.

Experience in Power Station Chemistry and/or Radiochemical analysis is essential. Possession of H.N.C. (Chemistry) or an equivalent qualification would be an advantage.

Postcards requesting Application Form SF/1 should be sent to the
Regional Personnel Officer,
Central Electricity Generating Board,
South Western Region,
Oakfield House, Oakfield Grove, Clifton,
Bristol, 8,
to whom the completed form (quoting Vacancy No. 220/63 (W) (N.S.)) should be returned by 7th August, 1963.

PILKINGTON BROTHERS LIMITED

Glass Manufacturers, require a

LIGHTING SPECIALIST

due to expansion of work in the Company's Daylight Advisory Service.

He should be skilled in basic photometry and illumination calculations and preferably have an interest in current lighting research especially that dealing with subjective studies. The service provided by the Company is a fee-based consultancy to architects and engineers and therefore some experience of consulting work and an interest in building would be an advantage.

The qualifications required are a university degree in electrical engineering or physics or the equivalent together with professional membership of the Illuminating Engineering Society.

Please quote H.O./T.S.2 in applying to
L. P. Laidlaw, Group Staff Department,
Pilkington Brothers Limited,
Grove Street, St. Helens, Lancashire.

THE ROYAL NATIONAL INSTITUTE FOR THE DEAF

Applications are invited for the post of ASSISTANT EXPERIMENTAL OFFICER in the Institute's Technical Department to work on the evaluation of hearing-aids, calibration of audiometers and general research concerning electro-acoustic apparatus. Applicants should be well versed in the field of electronics and acoustic measurement. Salary will be within the scales operating in the Government Scientific Service, £775-£1082 p.a. The post is an established one and a contributory superannuation scheme is in operation. Applications should be sent to the Director-General, RNID, 105 Gower Street, London, W.C.1.

THE UNIVERSITY of MANCHESTER

Applications are invited from candidates with medical qualifications registrable in this country for the full-time post of ASSISTANT LECTURER IN ANATOMY. Good research facilities are available. Salary per annum on a scale £1,200 to £1,670; initial salary according to qualifications and experience. Membership of Children's Allowance Scheme. Duties to commence as soon as possible. Applications should be sent not later than August 24th, 1963, to the Registrar, the University, Manchester 13, from whom further particulars and forms of application may be obtained.

METALLURGICAL RESEARCH laboratory requires metallurgists, age up to 30, with previous research experience, for investigations in the field of applied physical metallurgy. Salary according to age, qualifications and experience. Write: Secretary, B.N.F.M.R.A., Euston Street, London, N.W.1.

CHEMIST/BIOCHEMIST for Fermentation Research. At least 2nd Class Honours Degree with up to three years' relevant experience. 1963 graduates may apply. Good working conditions: five-day week; pension and bonus schemes.—John & E. Sturge Ltd., 1 Wheeleys Road, Birmingham 15.

COMMONWEALTH OF AUSTRALIA

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

DIVISION OF FOOD PRESERVATION

LEADER IN MEAT RESEARCH

Applications are invited for appointment as Leader of Meat Research in the Organization's Division of Food Preservation. The appointee will be located at Cannon Hill, Brisbane, where a considerable expansion of work on the preservation of beef will shortly take place. New Research Laboratories are soon to be built on land recently acquired at Cannon Hill, and it is expected that most of the Division's work on meat and meat products will eventually be carried out on this site. Plans provide for the present graduate staff of ten to be trebled during the next five years.

Current investigations being conducted, chiefly in Brisbane, include muscle biochemistry, physical chemistry of muscle proteins, some chemical aspects of meat quality, meat technology and bacteriology. The appointee will be required to advise the Chief of the Division on the development of new basic and applied Projects and the expansion of existing activities. Emphasis will be given to development of investigations which are basic to an understanding of the nature of meat and the changes which it undergoes during preservation and processing.

The appointee will be given considerable freedom to develop his own research interests. He will be required to establish close co-operation with other Divisional sections engaged in general food science studies, and also to maintain effective contacts with the Australian meat industry.

Candidates should have an established research reputation in one of the relevant scientific disciplines (biochemistry, physiology, microbiology, physics or chemistry), and should also have demonstrated ability to lead a research group and guide younger workers. Experience in meat research would be very desirable.

SALARY: Dependent upon qualifications and experience within the ranges of:

Chief Research Officer Grade I with a salary of £A4,558 p.a. or as a Senior Principal Research Officer within the salary range £A3,661-£A4,158 p.a.

Salary for a woman will be £A188 p.a. less than corresponding rates for men.

Promotion within C.S.I.R.O. is by merit and may go beyond the upper limit of the scale within which the original appointment is made.

Fares paid for the appointee and his dependent family. Further particulars supplied on application to:

Mr. P. F. Butler, Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2,

to whom applications (quoting Appointment No. 305/71) should be addressed by the **31st August, 1963.**

PROOF AND EXPERIMENTAL ESTABLISHMENT

Pendine, Carmarthenshire

War Dept. requires EXPERIMENTAL OFFICER or ASSISTANT EXPERIMENTAL OFFICER for provision and programming of instrumentation facilities to meet the requirements of trials and proof of weapons, ammunition, etc. on the Range. Also, instrumentation developments on new techniques, particularly sophisticated systems, and liaison with Trial Authorities.
QUALIFICATIONS: Over age 22 a degree, Dip. Tech., H.N.C., or equivalent is required.
EXPERIENCE: A good background in electronics and mathematics is required; knowledge of ballistics and/or telemetry an advantage.
SALARY: Experimental Officer (min. age 26) £1,164-£1,431
Assistant Exptl. Officer (age 22-27) £691-£1,053 (starting pay according to age)
The appointment is unestablished but there will be opportunities to compete for established posts.
A house will be available for the successful applicant, if married.
Forms from War Office, C5F, Whitehall, London, S.W.1. (5.)

D.S.I.R.

Building Research Station
Garston, Watford, Hertfordshire

ASSISTANT EXPERIMENTAL OFFICER to join a team working in the field of Building Design and Town Planning. The researches are aimed at assessing user satisfaction with various design aspects thus providing the basis for recommendations to designers. Duties include assisting in social surveys and field experiments, and analysing results.
QUALIFICATIONS: Degree in a natural science, or an appropriate Dip. Tech. or H.N.C. Training or interest in statistics or applied physics useful.
SALARY: £691 (age 22) to £858 (age 26 or over) to £1,053. Prospects to £1,431.
Forms from Director at above address. Closing date 12th August 1963.

D.S.I.R.

National Physical Laboratory
Teddington, Middlesex

ASSISTANT EXPERIMENTAL OFFICER/EXPERIMENTAL OFFICER, electronics engineer in the Basic Physics Division to work on development and maintenance of equipment for fundamental research in microwave and radio-frequency spectroscopy.
QUALIFICATIONS: Degree, Dip. Tech., or H.N.C. in Electronic Engineering, or equivalent.
EXPERIENCE: Actual experience in this field is not necessary but applicants should have a good knowledge of electronic circuitry including pulse and high frequency techniques.

SALARY. Experimental Officer (min. age 26) £1,209-£1,481
Assistant Experimental Officer £726 (age 22) to £898 (age 26 or over) to £1,098.

Forms from Director at above address. Closing date 12th August 1963. (5.)

THE UNIVERSITY of MANCHESTER

Applications are invited from persons with a medical or scientific qualification for two posts of ASSISTANT LECTURER IN BACTERIOLOGY. Appointment for three years in the first instance of which one will be spent in the clinical bacteriology laboratory of the Manchester Royal Infirmary. Salary scales per annum as follows: Medical (now under review), £1,200 to £1,650. Non-medical: £1,000 to £1,150. Membership of the F.S.S.U. and Children's Allowance Scheme. Applications should be sent not later than August 31st, 1963, to the Registrar, the University, Manchester, 13, from whom further particulars and forms of application may be obtained.

MEDICAL RESEARCH COUNCIL unit requires a technician to assist with biological work. G.C.E. "A" Level in Science subjects desirable. Salary according to age and qualifications in scale £385 to £980 p.a. plus London weighting. Apply with full details to the Director, Experimental Radiopathology Research Unit, Hammersmith Hospital, Ducane Road, London, W.12.

CENTRAL ELECTRICITY GENERATING BOARD
BERKELEY NUCLEAR LABORATORIES

FAST NEUTRON SPECTROMETRY

A vacancy exists for a Research Officer in the Physics Division of the Laboratories to join a small active group engaged in the measurement of fast neutron spectra.

Initially the successful candidate will be concerned with the application of nuclear emulsion techniques and the theoretical interpretation of the results. The group is equipped with a semi-automatic microscope and the laboratories have access to comprehensive computing facilities. Publication of original work is encouraged.

Candidates should possess a good Honours degree in physics, and have an interest in the correlation of experiments with theory.

● **For those who have recently completed Honours degrees or are completing post-graduate courses the initial salary will be in a range rising to £1,500 per annum. A graduate with more research experience may be appointed on a scale rising to £2,220 per annum. In both cases there are excellent prospects of early promotion to higher salary ranges.**

Applications stating age, qualifications, experience, present position and salary to the Personnel Officer (Headquarters), 24/30, Holborn, London, E.C.1. ***Quote Ref NS/227***

GOVERNMENT OF TANGANYIKA

Vacancy for a Chemist

Department of Agriculture

The Department of Technical Co-operation invites applications for appointment as Chemist, Department of Agriculture, Tanganyika.

Duties: Research work on coffee, including soil and plant analysis connected with nutritional problems and soil survey work.

Qualifications: Candidates (male) must have an honours degree in chemistry or equivalent qualification and not less than two years' post graduate experience or training.

Terms of Appointment: Appointment on contract/gratuity terms for one or two tours of 21-27 months with emolument in scale £1,265-£2,448. Gratuity 25% of total substantive emoluments. Free passages. Generous leave. Furnished accommodation usually available at low rental. Children's Education allowances.

Apply, stating full name and giving brief particulars of qualifications and experience, to Director of Recruitment, Department of Technical Co-operation, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting D45RC 213/145/05.

WAR OFFICE: ASSISTANT MAP RESEARCH OFFICERS. Nine posts (2 pensionable), at Feltham, Middlesex and Tolworth, Surrey, for men or women at least 21 on 1.8.63. Qualifications: normally hons. degree in geography or subjects which include geography, preferably with training or experience in cartography or surveying; knowledge of a modern foreign language, mathematics,or special library work an advantage. Graduates in Oriental or Slavonic languages, or in mathematics, may also apply if they have studied geography to G.C.E. "A" level standard, or have relevant practical experience, e.g. in cartography or surveying. Final-year students may apply. Exceptionally, non-graduates with specially relevant experience may be considered. Salary scale (Outer London) £831-1,220; starting salary may be above minimum. Promotion prospects. Write Civil Service Commission, 23 Savile Row, London, W.1, for application form quoting **5722/63/8.** Closing date 16th August 1963. (I.)

PROCESS SUPERVISOR required by RESEARCH INSTITUTE (ANIMAL VIRUS DISEASES), PIRBRIGHT, SURREY, in their Vaccine Production Unit to assist in process control. Applicants should, preferably, have had experience in aseptic procedures or training involving operation of plant in the biological field. Recruitment will be in the S.A./S.S.A. grade according to qualifications, experience and age. Salary scales—S.A. £675 at age 25 or over to £835; S.S.A. £868 to £1,159. Applications to Secretary.

PLANNING ADVANCED TECHNOLOGY

Unconventional semiconductor devices, metallic and non-metallic materials, energy conversion, superconductivity, biological sciences, and novel chemical engineering techniques are among the areas of future development in this large sponsored research organization.

Applications are invited for appointment as Section Leader or as members of a technical assessment group to undertake long-term planning. An honours degree in one of the applied sciences and several years' experience in research and development are essential for the senior post.

Selection will be on ability to apply basic principles and exercise judgment in evaluating technical and economic potential, and to present the results clearly. Staff are encouraged to participate in international conferences and to publish original work.

Career details should be sent to

The Personnel Manager
INTERNATIONAL RESEARCH & DEVELOPMENT CO LTD
Fossway, Newcastle upon Tyne 6

ALLEN & HANBURYS LTD WARE, HERTS

invite applications for a post as a Senior Technician in their Biochemistry Department of the Research Division. Applicants should preferably have a Higher National or equivalent qualification in Chemistry and/or A.I.M.L.T. or equivalent qualification in Chemical Pathological techniques. Experience in enzyme Biochemistry and general Biochemical Analytical methods is desirable. The work involves the study of the metabolism of new drugs. Applications, in writing, should be addressed to the Personnel Manager, and should quote ref. No. B.T.2.

UNIVERSITY OF DURHAM

Laboratory Technicians

There are vacancies for Technicians (over 21 years of age) and Junior Technicians in the Department of Chemistry, Durham University Science Laboratories. Applicants, at least at Technician level, should have had some experience of work in Chemical Laboratories.

Starting salary will be at an appropriate point on the National Salary Scale for University Technicians (Technicians £540-£745 a year; Junior Technicians £265-£420 a year), according to age, qualifications and experience, with a Pension and Life Assurance Scheme after a minimum of three years' service. Qualifications such as National Certificate, City and Guilds of London Certificate or G.C.E. would be an advantage, and would also, in certain cases, entitle holders to an extra allowance of £30-£50 a year.

Technicians and Junior Technicians are encouraged to continue their part time education and there will be opportunity for promotion to higher grades.

Applications in writing giving full details of age, qualifications and experience, together with copy testimonials or names of two referees should be sent to the Deputy Secretary, Science Laboratories, South Road, Durham, on or before 9th August, 1963.

THE UNIVERSITY of MANCHESTER

Applications are invited for the post of EXPERIMENTAL OFFICER in the Department of METALLURGY. Duties will commence as soon as possible after 1st October, 1963. The officer will be responsible for the maintenance of X-ray equipment for undergraduate teaching and for research. He will take part in the development of those research projects which rely largely upon X-ray techniques and should be able to give some service assistance to other projects. Candidates should be familiar with standard X-ray diffraction apparatus and techniques, preferably with some knowledge of counter methods, low angle scattering, fluorescence analysis or texture determination. Some experience with electronics would be an advantage. Qualifications in physics or metallurgy are desirable, for example, graduate membership of the Institute of Physics, or L.I.M. Salary range: £880 × £40 to £1,200 per annum. The initial salary will be according to qualifications and experience. Contributory superannuation scheme. Applications should be sent not later than 10th August 1963 to the Registrar, the University, Manchester 13, from whom further particulars and forms of application may be obtained.

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING
(University of Reading)

Applications are invited from graduates holding an honours degree in chemistry, biochemistry or agricultural chemistry or in a closely allied field for a research fellowship tenable for 3 years under a grant from the U.S. Department of Health, for work in the field of protein nutrition. The Fellow will be concerned with the development of methods of determining the nutritive value of proteins and in particular with investigations of the significance of blood amino acid levels in experimental animals as indicators of the quality of ingested protein. An automatic amino acid analyser is being installed for these studies. Suitable candidates may be allowed to register for a higher degree in the University of Reading. Salary from £791 p.a.; F.S.S.U. Applications, naming two referees, to the Secretary, N.I.R.D., Shinfield, Reading, quoting ref. 63/11

NEW ZEALAND

Agriculture Department

Applications are invited for the undermentioned vacancy:

Vacancy B13/2/20/1960: Technician (Male or Female) Diagnostic Section, Ruakura Animal Research Station.

Salary: Up to £1,570 a year, depending on qualifications and experience.

Qualifications desired: F.I.M.L.T. with extensive experience in histological techniques is desirable.

Duties: To take charge of the Histological laboratory of the Diagnostic Section.

Passages: Fares for appointee and his wife and family, if married, will be paid.

Incidental Expenses: Up to £35 for a single man and £100 for a married man can be claimed to cover the cost of taking personal effects to New Zealand.

Application forms and general information are available from the High Commissioner for New Zealand, New Zealand House, Haymarket, London, S.W.1, with whom applications will close on 30 August, 1963.

Please quote reference B13/2/20/1960 when enquiring.

WORKS ENGINEER

A maintenance engineer is required to take charge of all aspects of engineering in a chemical factory in N.W. Kent. Duties include advising on new plant and processes and controlling the purchase and installation of new equipment.

Applicants should be qualified engineers with at least five years' experience in the chemical industry. Experience of corrosive and/or food materials would be an advantage.

For further details write to Box C879 NEW SCIENTIST giving brief details.

UNIVERSITY OF BIRMINGHAM

Department of Botany

Research Assistantship

Applications are invited for the post of Research Assistant in cytological and associated fields. The work will include preparation of plant material for optical and electron microscopy, and recording and testing in connection with breeding programmes.

Candidates should have a degree in Botany. Previous experience is not essential, since all necessary training will be given.

The appointment will be initially for a probationary period of one year, renewable up to two further years. Salary in the range £525-£675 p.a.

Applications, naming two referees, should be addressed to Professor J. Heslop-Harrison, Department of Botany, University of Birmingham, Birmingham, 15, to arrive before 3 August 1963.

ASSISTANT TECHNICAL INFORMATION OFFICER required in the Central Technical Library and Information Department of a leading industrial company. Applicants with a degree in science or technology or equivalent preferred. Experience in an industrial library or information department and knowledge of foreign languages an advantage. The successful applicant's work will be concerned chiefly with answering technical inquiries, the compilation of bibliographies and assisting with the preparation of technical abstracts and bulletins. The department located near London provides technical library and information services for the company's work and research and development groups. Applications with details of experience and qualifications to Box No. C881 NEW SCIENTIST

THE UNIVERSITY OF HULL

Department of Physics

Applications are invited for an appointment as Research Assistant for work on infra-red lasers under Professor G. F. J. Garlick tenable from 1st October, 1963. Preference given to candidates with research experience. Salary scale £900-£1,100 per annum. Further particulars from the Registrar, the University, Hull, with whom applications (2 copies) naming three referees should be lodged by 9th August, 1963.

TECHNICIANS WANTED in CHEMISTRY Department, one for research and one for teaching laboratories. Candidates should have appropriate qualifications; experience in teaching laboratory is desirable. Applications, giving names of referees, to the Secretary, Queen Elizabeth College, Campden Hill Road, W.8, immediately.

CHEMISTS required in Sugar Refinery for shift and day work on production control. Experience in food analysis or on production control essential. Salary according to qualifications and experience. Apply to Manbre Sugars Ltd., Hammersmith, W.6.

COMMONWEALTH OF AUSTRALIA

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

DIVISION OF ANIMAL PHYSIOLOGY

RESEARCH OFFICER FOR PHYSIOLOGY INVESTIGATIONS

Applications are invited for research appointments with the Organization's Ian Clunies Ross Animal Research Laboratory located at Prospect, N.S.W. The Laboratory is situated 20 miles west of Sydney and is the headquarters of the Division of Animal Physiology, with which is associated a Pastoral Research Laboratory at Armidale, 350 miles north of Sydney.

The Division comprises three units: (i) The Ian Clunies Ross Animal Research Laboratory at Prospect, N.S.W. (ii) the Pastoral Research Laboratory at Armidale, N.S.W. and (iii) a beef cattle research group accommodated at the Cunningham Laboratory of the Division of Tropical Pastures at Brisbane, Qld. The Division's work is chiefly concerned with the productivity of sheep; research on beef cattle has been started. Major fields of study are the following: physiology of reproduction, wool growth, nutrition, climatic physiology, intermediary metabolism, endocrinology, bioenergetics, dermology, renal physiology, physiology of digestion, ecology and animal production from pasture.

Appointments are available in the following fields:

(a) Climatic physiology. Current work is concerned with heat and cold stresses, and the influence of climate on wool growth and reproduction of sheep. Special equipment to provide artificial climates has been installed.

(b) Wool growth—many aspects of the physiology and bio-chemistry of wool growth are being studied at present. Preference will be given to an applicant who is willing to develop research on nutritional, cytological or morphogenetic lines.

(c) Bioenergetics—two closed circuit respiration chambers are in continuous use and more chambers are to be built.

The Chief of the Division would also be interested to receive enquiries from biologists who would like to work on other aspects of the Division's general research programme.

Applicants should possess a Ph.D. degree in Science, Agricultural, Rural or Veterinary Science or have had post-graduate research experience of an equivalent standard and duration supported by satisfactory evidence of research ability. Previous experience in research with sheep is not essential.

SALARY: Dependent upon qualifications and experience within the ranges:

£A1,541-2,296 p.a. (but not less than £1,816 p.a.) or £A2,426-2,751 p.a.

Salary for a woman will be £A188 p.a. less than corresponding rates for men.

Promotion within C.S.I.R.O. is by merit and may go beyond the upper limit of the scale within which the original appointment is made.

Fares paid for the appointee and his dependent family. Further particulars supplied on application to:

Mr. P. F. Butler, Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, W.C.2,
to whom applications (quoting Appointment No. 247/277) should be addressed by the **31st August, 1963.**

MSL

have been retained to advise on this appointment

TECHNICAL MANAGER Hard metal products

for a company within 50 miles of London employing over 300 and making hard metal products including cutting and mining tools. He will be responsible to the Managing Director for the development of new and improved products and processes.

A degree or equivalent in metallurgy, physics, mechanical engineering or chemical engineering is required, together with some years' experience of leading research or development teams in industry or research associations in powder metallurgy or an allied field.

Age 35 to 45. Initial salary not less than £2,500. Appointment to the Board in a few years' time can be earned. Brief details in confidence are invited by P. Hook, reference AQ.5809. In no circumstances will a candidate's identity be disclosed to our client unless he gives permission after a confidential interview at which he will be given details of the appointment.

MANAGEMENT SELECTION LIMITED
17 Stratton Street, London, W.1.

PARIS . NEW YORK . DUBLIN . GLASGOW . MELBOURNE . SYDNEY

Specialist advisers in management planning and succession

COMMONWEALTH OF AUSTRALIA

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

DIVISION OF LAND RESEARCH AND REGIONAL SURVEY

SOIL CHEMIST

Applications are invited for the position of Research Officer or Senior Research Officer (Soil Chemist) with the Organization's Division of Land Research and Regional Survey with Headquarters at Canberra, A.C.T.

The Division has for the last fourteen years been conducting land potentiality surveys on the Australian mainland, and more recently reconnaissance surveys in New Guinea. Soil samples collected in the course of surveys in New Guinea have posed a number of chemical and physical problems.

In collaboration with soil scientists the appointee will undertake chemical investigations on New Guinea soils with particular reference to the clay fraction. Problems to be studied include: changes induced by drying, aspects of clay dispersion, the relationship between exchange properties and acidity and the possibilities that narrow C-N ratios are caused by absorbed ammonium.

The appointee will be located at Divisional Headquarters in Canberra, but will be expected to undertake some field work in association with the soil scientists.

Applicants should possess a Ph.D. degree or should have had postgraduate research experience of equivalent duration and standard, preferably in soil chemistry, supported by satisfactory evidence of research ability.

SALARY: Dependent upon qualifications and experience within the ranges:

£A1,541-2,296 p.a. (but not less than £1,816 p.a.) or £A2,426-2,751 p.a.

Salary for a woman will be £A188 p.a. less than corresponding rates for men.

Promotion within C.S.I.R.O. is by merit and may go beyond the upper limit of the scale within which the original appointment is made.

Fares paid for the appointee and his dependent family. Further particulars supplied on application to:

Mr. P. F. Butler, Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, W.C.2,

to whom applications (quoting Appointment No. 618/135) should be addressed by the **24th August, 1963.**

THE GENERAL ELECTRIC COMPANY LIMITED

HIRST RESEARCH CENTRE

Applications are invited from

HONOURS GRADUATES

in

Physics, Electrical Engineering and Mathematics

to join Groups working on discharge lamp research, discharge lamp circuitry and ballast design, and also photometric, electrical and thermal measurements for Illuminating Engineering. There is one opening for a candidate having a pass degree or H.N.C. The work is conducted in modern laboratories with first class equipment. Apply in writing giving brief details to the Staff Manager (Ref. B/717/D), G.E.C., Hirst Research Centre, Wembley, Middlesex.

INDUSTRIAL STATISTICIAN

A young industrial statistician is required to take over a small section engaged on establishing statistical process and quality control techniques and assisting with research and development programmes. Preferably he should have a degree in statistics or applied science, although other suitably qualified men will be considered. Experience in the engineering industry is required.

The post is at Doncaster. An attractive salary and conditions of service are offered.

Write, giving full details to:

L. T. Hems, Esq.,
Head of Group Consulting Services,
BRITISH ROPES LIMITED,
Warmsworth Hall,
Doncaster, Yorkshire.

HAWKER SIDDELEY DYNAMICS LIMITED

have vacancies for

3 Physicists and 3 Electronic Engineers

to carry out research into advanced infra-red techniques, system design and development of infra-red detection and tracking systems.

These posts require the application of initiative and originality to theoretical and practical aspects of new and existing projects.

The projects involve evaluation of properties of materials for infra-red detectors and optics, system and circuit design, liaison with production teams and analysis of trials results.

Applicants should have a degree in electrical engineering or physics, and although some knowledge of electronic or infra-red techniques would be desirable, this is not essential.

There are also a few vacancies for

TECHNICAL ASSISTANTS

to work with the above engineers and physicists. Some experience in electronic or light mechanical laboratories is desirable but applications from young men with advanced level mathematics and physics would be considered.

Applications should be addressed to:

The Personnel Manager (Ref 244),
Hawker Siddeley Dynamics Limited,
Manor Road,
Hatfield, Herts.

THE MIDLAND CENTRE FOR NEUROSURGERY AND NEUROLOGY

Holly Lane, Smethwick 41

Applications are invited from Graduates with an Honours Degree in Biochemistry or Chemistry for the appointment of Biochemist. The appointment will be made at either the Senior or Basic Grade. For the Senior Grade experience of Clinical Biochemistry is desirable.

In addition to routine duties the successful applicant will be expected to take part in the Research Work of the department. This is concerned mainly with Cerebral Circulation studies and Cerebral Metabolism.

The Hospital is recognised by the University of Birmingham as providing adequate facilities for PH.D studies in the faculty of science.

Intending applicants are advised to visit the Hospital by appointment with the Hospital Secretary (telephone SME 2311). Applications giving full details of qualifications, experience and names and addresses of two referees should be addressed to The Group Secretary, West Bromwich and District Hospital Management Committee, Edward Street, West Bromwich.

BATTERSEA COLLEGE OF TECHNOLOGY London, S.W.11

I.C.I. Research Studentship in the Department of Civil Engineering

Applications are invited from honours graduates for a Research Studentship established by I.C.I. Limited (Plastics Division), for research on the structural use of plastics.

The successful candidate will be expected to register for a Ph.D. degree of the University of London. The scholarship will be awarded in the first instance for one year, but if the progress is satisfactory would be extended for another two years.

Salary according to qualifications and experience but not less than £750 per annum. Duties to commence on 1st October, 1963.

Further particulars may be obtained from the Head of the Department of Civil Engineering, to whom applications should be submitted by not later than 31st August, 1963.

SENIOR TECHNICIAN, Physics Department, Queen Mary College (University of London), Mile End Road, E.1. To assist in maintenance and running of low temperature services including air and helium liquefiers and other high grade machinery. Direct experience not essential but experience with marine or submarine machinery advantageous. Occasional evening work by arrangement. Post might suit a former marine or submarine engineer. Initial placing according to ability etc. on scale £760 by 25/30 to £900 p.a. Plus London Weighting up to £45 p.a. and possible £30 or £50 qualifications supplement. Five day week. Four weeks' annual leave. Pension scheme. Letters only to Registrar (PST) should state full details experience and present work.

TISSUE CULTURE TECHNICIAN required for work on Radiobiology Unit. Previous experience in this field preferred but training is available for someone experienced in related subjects, e.g. nursing and bacteriology. Applications, with names of two referees, to the Secretary, the Medical College of St. Bartholomew's Hospital, West Smithfield, E.C.1

AEI

ASSOCIATE EDITOR

required for 'AEI ENGINEERING', technical journal of Associated Electrical Industries Ltd. to work in Rugby and to assist the Editor (in London) in preparation and production of the journal and its special issues: to keep editorial liaison with the printers in Rugby: to initiate, collect and edit articles drawn from the Midlands Divisions of AEI: to be responsible for certain regular features of the journal.

Qualifications, knowledge of science and engineering, preferably electrical and or electronic: ability to write and edit. He should have an interest in the visual presentation in print of technical material.

Reply to Personnel Officer, AEI, 33 Grosvenor Place, London, S.W.1.

INFORMATION ASSISTANT

BRITISH NYLON SPINNERS

have a vacancy for a science graduate in their Library and Information Service. The work is interesting and varied with scope for initiative. Previous experience of information work is desirable but not essential.
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